
EX LIBRIS
G Brown Goode
SIBI
ET AMICIS
AIX 1634 — BARBADOES — NEW ENGLAND
NEW JERSEY — VIRGINIA — OHIO
Ffor hym was lefere to have at hese bedis hed
Twenty bokis I-clad in blak or red
Of Aristotle & his philoso-phie
Than robis ryche or fedele or gay sautrie
S. I.
U.S. National Museum
S. I.

Nature

A WEEKLY

ILLUSTRATED JOURNAL OF SCIENCE

VOLUME XXXI

NOVEMBER 1884 to APRIL 1885

*"To the solid ground
Of Nature trusts the mind which builds for aye."*—WORDSWORTH.

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NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE

" To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH

THURSDAY, NOVEMBER 6, 1884

TWO BEE BOOKS

A Collection of Papers on Bee-keeping in India. Published under the Orders of the Government of India, in the Revenue and Agricultural Department, 1883. (Calcutta: Office of the Superintendent of Government Printing, India, 1883.)

The Honey-Bee: its Nature, Homes, and Products. By W. H. Harris, B.A., B.Sc. With Eighty-two Illustrations. (London: The Religious Tract Society, 1884.)

THE thin folio issued by the Indian Government is very redolent of red-tape, since it contains not only a large number of reports from forest and district officers, and other persons in various parts of India, but also the whole of the official correspondence, memoranda, and indorsements connected with the same. Moreover, it is almost a misnomer to call it a collection of papers on "Bee-keeping," since at least nine-tenths of the reports state that domesticated bees are quite unknown in their districts; and the bulk of the matter (nearly a hundred pages of close print) is occupied with accounts of native methods of taking the combs of wild bees and preparing the wax, and with very imperfect descriptions of the various kinds of honey-producing bees in each district. The general result of the inquiry, as stated in a "Resolution" of the Revenue and Agricultural Department, is the following:—

"The industry is unlikely ever to be one of great importance in India. It can only be followed in the hills, where flowers abound throughout the greater part of the year, or in forests, where food is equally plentiful. In the populous country of the plains, bee-keeping as a general industry seems impracticable. Under these circumstances there is little or no call for action on the part of the Government."

Notwithstanding this somewhat depressing outcome of a laborious inquiry, some interesting details may be found in the storehouse of facts here brought together. At the commencement of the Report attention is drawn to Moorcroft's account of bee-keeping in Cashmere:—

"Their domestication there is so general that in some parts of the country a provision is made for hiving them in every house as it is being built. Spaces are left empty in the walls about 14 inches in diameter, and 2 feet, the average thickness of the walls, in length, which are carefully lined with a mixture of mortar, clay, and chopped straw, and closed at the inner end with a flat tile. There are ten or a dozen of these hives built into the walls of every house. The bees are hived exactly as in Europe, but the comb is gathered differently and in a way well worth following at home. It is done by the father of the house removing the flat tile, and at the same time blowing the smoke of a smouldering wisp of straw he holds in the other hand vigorously through the hive, on which the bees at once leave the hive, and he gathers in their store of honey. He then replaces the flat tile at the inner end of the hive, and the bees, after recovering their stupefaction, gradually return to it. The same colony of bees thus produce honey year after year in the same hive, and generation after generation, and have probably done so from the original Aryan settlement of the Cashmere Valley. In consequence of their being thus literally domiciliated with the human race, the bees of Cashmere are milder in their manners than those of any other country, although they have a most villainous sting when unduly provoked to use it. Their honey is as pure, and clear, and sweet, Moorcroft says, as the finest honey of Narbonne."

In a statement on bee-culture in Cashmere by a zemindar, it is said that hives are now very numerous, as they have been on the increase for several years, and the method of keeping them is very similar to that described by Moorcroft. But Mr. R. Morgan, Deputy Conservator of Forests, Madras, protests against the recommendation of smoking out the bees, as barbarous. It is, however, no doubt well suited to native wants, as hives are not required to be indefinitely increased, and there is no sale for swarms.

A very simple mode of bee-keeping is described as practised by the people of Mysore:—

"In March or April they besmear the concave part of an old earthen pot with honey-wax, make holes in the pot, take it to the jungles, and place it upside-down on a piece of wood or a slab of stone. The bees are attracted to the pot by the smell of the wax, and, when the person intending to domesticate them finds, after a trial of four or six days, that they have taken to remain in the pot, he goes to the jungle on a dark night, removes the pot after

having covered it with a blanket, and places it either on a tree near or under the eaves of his house, or in any adjoining place. Each man keeps pots varying in number from one to four. He need not do anything beyond keeping the pots as aforesaid. They store honey between April 15 and June 15; and between the latter date and the end of July the keeper gathers it in, leaving a small portion to serve as food for the bees."

Mr. R. Morgan, Deputy Conservator of Forests, Madras, gives an interesting account of the honey-bees of the Wynaad. He says that the best honey-producing flower of Southern India is the Strobilanthes, of which there are numerous species, which almost all flower once in seven years, dying down entirely, and afterwards a fresh growth springing up from seed. The Strobilanthes is a shrubby genus of Acanthaceæ, mostly with blue or purple flowers, and the statement about their flowering only once in seven years is probably a popular delusion, like that of the Aloe flowering once in a century. The bees build their combs on the ledges of inaccessible precipices, often overhanging rivers, or on lofty horizontal limbs of the largest forest trees, and the combs are usually $3\frac{1}{2}$ to 4 feet in length and 2 feet in diameter. The natives take the honey on dark nights by means of long cane or bamboo ladders, either erected against the tree or rock or suspended from above, and they carry torches, and knives to cut away the combs. The bees are roused by the glare of the torches, but do not sting, although in the daytime they are terribly pugnacious, and many a sportsman and traveller has barely escaped with his life after disturbing them. Mr. Morgan states that he can give numerous instances of men, cattle, horses, and even fowls and pigeons being killed by these bees.

The Deputy Conservator of Forests, East Salween, describes some remarkably large combs, one of which was 7 feet long and 6 feet deep in the widest part. The bees are fond of particular trees, and he states that on one Kanyin tree (*Dipterocarpus alatus*) he counted no less than thirty-nine combs, some of prodigious size. The trees are here ascended by means of pegs driven in the trunk, as in Borneo, and the bees are partially stupefied by a smoke torch.

These are samples of the better kind of reports that have been obtained from hundreds of districts in India. There is a monotonous similarity in large numbers of them, and it may be doubted whether the information afforded is worth the labour and cost it has entailed.

Mr. Harris's little volume on "The Honey-Bee" affords a striking contrast to the preceding work, both in its elegant get-up and excellent illustrations, its wide range of matter, and the clearness and condensation of its style. It treats in a pleasant and well-informed manner not only of bee-keeping but of the bees themselves and all that relates to them. We have a chapter on the literature of bees, from the Egyptian monuments and the Vedas to Shakespeare, Huber, and modern writers. Each subject is treated in a separate short chapter, so that we have chapters on "The Queen Bee," "The Workers," "Wax," "Bee-bread," &c., and even one on "Mead," including its use in ancient times and Queen Elizabeth's receipt for its manufacture. Hives, the Enemies, and the Diseases of Bees are all separately treated, as well as their "Intellect and Instinct," their "Relation to Flowers," and the "Superstitions connected with Bees."

From so condensed a work it is difficult to find passages suitable for extract, but the following illustration of the powers of intellect manifested by bees may be taken as a fair specimen of the author's style:—

"Again, let us revert to the manufacture of queens by the workers. If at the time of the removal or loss of the mother-bee in any way, there should be unhatched princesses in the hive, no attempt will be made to follow the course adopted in the absence of such royal progeny. In the *latter* case—that is, when there is no royal brood—there must be a distinct conception, first, of their bereavement; secondly, of the hopelessness of a sovereign appearing in the ordinary way. Then a judgment is formed of the proceedings necessary for making a queen, and action immediately follows. Not only so, but as if to secure themselves against the repetition of their calamity, they prepare not *one* queen, but *several*, so that, if the first which comes to maturity be lost, there may be others in reserve. A further act of definite judgment appears in this; for if one only were produced and lost, they would be powerless to repeat the process, as all the rest of the worker brood would, in the meantime, have advanced far beyond the stage at which its transformation would be possible. The bees then, with admirable prevision, forbear to risk all the future of their community on one hope of a queen."

In adducing the construction of the cells as a proof of pure instinct of the highest order, Mr. Harris is hardly on secure ground, since he omits to notice the researches of Mr. Darwin proving that the method of cell-building is very simple, and consists, fundamentally, in forming circular cells the size of which is determined by that of the bee's body, and gnawing away all the superfluous wax in the angles till the hexagonal form is produced. He is also hardly justified in the statement that "all these and other circumstances connected with the construction of their dwellings attest the possession of an innate faculty *needing no instruction from the elders of the hive*." The last statement (which we have italicised) is surely unprovable, and as every young bee necessarily begins work in the midst of her elders, and has done so during the countless generations of the past, it seems more probable that a considerable portion, though not perhaps the whole, of the bees' wonderful constructive power, is due to direct imitation and instruction.

On the whole, we can recommend this little book as a very comprehensive summary of what is known about bees and bee-keeping, at once attractive to the young who wish to learn something about these marvellous little creatures, and at the same time containing all the information necessary for the beginner in apiculture. The illustrations are both well chosen and beautifully executed, and the work is altogether so daintily got up as to render it especially suited for a gift to intelligent boys and girls.

A. R. W.

DR. KLEIN ON MICRO-ORGANISMS

Micro-Organisms and Disease. By E. Klein, M.D., F.R.S. (London: Macmillan and Co., 1884.)

THERE can be no doubt of the value and excellence of this little book. Dr. Klein is one of the very few men in this country who are continually working and experimenting with Bacteria and similar forms. His

instructions and advice as to methods of study are invaluable, and his opinions on the numerous debatable questions connected with micro-organisms entitled to the highest respect. Dr. Klein has descended, as it were, from his position of experimentalist and observer, in order to place before the scientific public in a compact form a *résumé* of what is known at this moment concerning disease-producing micro-organisms. He classifies these organisms as Micrococci, Bacteria, Bacilli, Vibriones, Spirobacteria, Yeast-fungi, and Mould-fungi, and gives *seriatim* under each head, accompanied by numerous figures, often original, an account of such forms as have been found in association with disease. He refers the reader to the original writings in which this or that organism has been described, and whilst he sometimes judiciously throws doubt on a claim to pathogenic powers, he is entirely relieved from the responsibility of a critic in all cases by the disclaimer in his preface and by the fact that he obviously intends to leave the question in most cases to further inquiry. As an illustrated catalogue of reputed pathogenic Schizophytes, with references to original authorities, the work is invaluable.

At the same time Dr. Klein does, as so ripe a student of these questions must, commit himself to very definite opinions on some of the great problems of what it is convenient to term "Bacteriology." Dr. Klein clings to the belief that speaking broadly the forms known as Micrococci, Bacteria, Bacilli, Vibriones, and Spirilla breed true and are to be recognised as true genera. This opinion is traceable to the fact that his studies have been chiefly (like those of Koch, who holds a similar view) carried out on parasitic (*i.e.* pathogenic) Schizophytes. And it is highly probable that it is more difficult (in some cases impossible) to break down the specific form by change of environment of a parasitic Schizophyte than of free-living kinds. But Dr. Klein has himself shown (p. 109) that Bacillus (*B. anthracis*) when cultivated in a certain way becomes Micrococcus (torula-form), and other similar instances are to be found in his book. Had he dealt with free-living Schizophytes as well as parasitic ones, he would have found ample evidence of the transformation, in the course of growth and division, of Micrococci into Bacteria, of these into Bacilli, and of these into Vibriones and Spirilla, and of each of these directly or indirectly into the other forms. The instability of the forms presented by particular kinds of Bacteria does not however imply, as has been assumed by some writers (Billroth *e.g.*), that there is only one "species" of Schizophyte. Such use of terms would lead to the statement that there is only one "species" of organism in all creation. The instability of the forms of Schizophytes merely implies that the range of presently observable specific characters taken as a whole (which forms the true limits of what mankind at the moment calls a "species") is *not* simply and directly coincident with the range of one particular and readily observed set of characters, namely, those of form. A great deal more depends upon the question of transmutability of the forms of Schizophytes than is admitted, at present, by pathologists. We would merely warn them that the doctrine of fixity of the forms of pathogenic Schizophytes is as much an *assumption* and as much to be received with caution as is the contrary doctrine of the universal transmutability of such forms. One great fact is certain, viz. that *some* Schizophytes do exhibit the *positive* evidence of change of form in the course of growth under varying conditions.

Dr. Klein has a most interesting chapter on the conversion of innocuous into pathogenic organisms and *vice versâ*, in which he criticises with great ability the results of Buchner and Nägeli on the one hand, and of Pasteur on the other. Valuable as such critical dissertations are, Dr. Klein will agree with us in thinking his experiments of greater value. We should be sorry were the test-experiments which they suggest to be delayed in consequence of the apparently satisfactory character of the reasonings which he and others have very properly adduced. The fact is that the proportion of what we know by careful experiment and observation in reference to Bacteria and their allies—as compared with what we must soon know and can see how to know if only time and ability are directed to the research—is so small that conclusions and generalisations are not useful except as suggestions to those who are in the thick of the work. More experiment, more trial of every conceivable condition of growth and nutrition, applied to every kind of Schizophyte observed and yet to be discovered, is imperatively called for.

Who can say that much is known as yet about these organisms, when even so earnest a student of them as Dr. Robert Koch did not know that his so-called "cholera comma-Bacillus" occurs in the mouths of nearly every healthy man, woman, and child?

Dr. Klein has rendered a generous service to future students of Bacteria by the publication of this little book. The woodcuts are very abundant, and sufficient to give an idea of the forms as they appear when stained by coloured reagents. The botanical and chemical aspects of the Schizophytes are necessarily not dealt with in this treatise.

E. RAY LANKESTER

OUR BOOK SHELF

A New Method of treating Glaucoma, based on recent researches into its Pathology. By Geo. Lindsay Johnson, M.A., M.B., B.C. Cantab. (H. K. Lewis, 1884.)

THIS little *brochure* is written by a Cambridge graduate who has devoted considerable time and attention to the study of diseases of the eye, and who has devised a new and very serviceable form of ophthalmoscope. The proposition he endeavours to establish is "that the ordinary method of treatment for glaucoma by iridectomy, though highly successful in acute forms of the disease, is nevertheless both uncertain and unsatisfactory in the chronic condition of glaucoma." The truth of this proposition all those who have had large experience in the performance of operations on the eye will freely admit: the reason is less easy to give. Dr. Johnson describes the lymphatic system of the eye, and adduces evidence to show that the aqueous humour is secreted by the ciliary processes and posterior surface of the iris, whilst it is drained off by the canal of Fontana, and the meshwork at the corneo-iridal angle. Any circumstance obliterating this angle is apt to induce glaucoma. It is certainly not due to swellings of the lens, since Brailey has shown that the lens is smaller in the glaucomatous than in the normal eye, but Dr. Johnson thinks that acute glaucoma may be referred to swelling and inflammation of the ciliary processes, whilst in chronic glaucoma there are slow and gradual changes in the ciliary body and in the lesions around the angle of the anterior chamber, which in his opinion explains the

different effects of iridectomy in cases of acute and chronic glaucoma. Dr. Johnson then proceeds to describe an operation which he terms scleral paracentesis, and describes as new, but which we have seen performed both by Mr. Hancock and by Mr. Power many years ago. In point of fact, Mr. Hancock's operation was a scleral paracentesis, and his view, which is not altogether incorrect, and was based on observation, was that in glaucoma a circumcorneal depression could be seen which he imagined to be due to the ciliary muscle, and his section, made with the same instrument recommended by Dr. Johnson, namely, a Wenzel's double-edged knife, was made through the sclera with the object of dividing the ciliary muscle; and the excellent results obtained in some cases show clearly that the escape of the vitreous which followed the incision, accompanied, when the anterior chamber was opened, by the aqueous humour, was quite enough to afford relief to all the symptoms and to restore vision, even if the spasm of the ciliary muscle was quite imaginary. We do not, however, wish to deprive Dr. Johnson of the credit of having thought out this method of procedure, though he may rest assured that he will meet with many cases of chronic glaucoma that will derive no benefit from scleral paracentesis, and that he will have to be careful in promising success from his operation in such cases.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

An Unnoticed Factor in Evolution

Two observed biological facts seem to oppose great difficulties to any explanation on evolution principles; difficulties admitted by evolutionists as well as their opponents. I mean—

(1) The fact that varieties produced by artificial selection, however divergent, are always fertile among themselves, while species supposed to have been produced naturally by an analogous process are often not mutually fertile even when very slightly divergent; and

(2) The fact that species evidently derived from a common ancestor, and differing only in small points of marking, though not fertile with one another, are often found side by side in places where it would seem that cross-breeding must prevent any division of the ancestral species into divergent branches.

The first seems to require that a period much greater than that of artificial selection should be necessary to produce sterility between descendants from the same ancestor; a supposition which would require an almost incredible period for evolution as a whole. The second seems to require that many species now intermixed should once have been geographically separated, sometimes in cases where this is very difficult to imagine. Both these difficulties are completely removed if we suppose mutual sterility to be not the *result* but the *cause* of divergence.

As far as can be judged, "sports" are as likely to occur in the generative elements (ova and spermatozoa) as in other parts of the body, and from their similarity in widely unlike groups it seems certain that a very slight variation in these elements would render their owner infertile with the rest of its species. Such a variation occurring in a small group (say the offspring of one pair) would render them as completely separate from the rest of their species as they would be on an island, and divergence (as Wallace has sufficiently shown) would begin. This divergence might progress to a great or a small extent, or even be imperceptible, but in any case the new species would be infertile with the species it sprang from.

If this theory be admitted, we must distinguish between varieties and species by saying that the former arise by spontaneous variations in various parts of the body, and only gradually become mutually infertile (thus becoming species), while the latter arise sometimes in this way, but sometimes by spontaneous variations in the generative elements, and are in this case originally mutually infertile, but only gradually become otherwise divergent.

I would suggest the following tests, and should be glad of any facts, from experience or from books, which can help in applying them:—

(1) If this theory is true we ought to find species (incipient) mutually infertile, but not otherwise distinguishable; and

(2) We ought to find that island and other isolated species which have arisen not by limited fertility but by geographical instead of physiological separation are often mutually fertile even when as widely divergent as the artificial varieties of dogs or pigeons.

EDMUND CATCHPOOL

The Grove, Totley, Sheffield, October 23

Earthquake Measurement

IN an article on "Earthquakes" in last week's NATURE (p. 608), Dr. H. J. Johnston-Lavis takes exception to the records of earthquake motion which I have published, on the ground of their complexity, and pronounces the Plain of Yedo unsuitable for earthquake observations.

Now this seems to me to be a very eclectic way of treating earthquakes. We can measure earthquakes only where we find them, and I suppose the first qualification in a site for an earthquake observatory is that there should be plenty of earthquakes. The Plain of Yedo possesses this qualification in a very high degree; and if the disturbances which occur in it are of a very much more complex character than our *a priori* notions about earthquakes may have led us to expect, it is not the Plain of Yedo that is to blame.

I fully agree that on a rocky formation the results will be different from those I found on an alluvial plain, but the instruments and methods which have been successful on the one are just as applicable to the other. The seismometers which have been used in Japan will serve to measure, with equal accuracy, earthquakes of a similar degree of destructiveness in other places, whatever be the nature of the ground. And several of the types already employed need little more than a change of scale in their construction to suit them for such formidable convulsions as the Ischian earthquake, to which your correspondent refers.

In describing and figuring a number of proposed seismographs, Dr. Johnston-Lavis has very frankly disclaimed a technical knowledge of mechanical construction, and for that reason all minute criticism of his suggestions may be withheld. If however he will refer to the *Transactions* of the Seismological Society of Japan, or to my "Memoir on Earthquake Measurement," he will see that some of the devices he suggests are not new. The plan of registering the amplitude of a pendulum's motion relatively to the earth by making the bob draw up a thread through a hole in a plate fixed below it was used some years ago by Dr. G. Wagener; and a massive slab free to roll on spherical balls formed in 1876 the seismometer of Dr. G. F. Verbeck. It was reinvented a year or two ago by Mr. C. A. Stevenson, and described by him before the Royal Scottish Society of Arts. The theory of the apparatus is discussed in §§ 31-32 of my memoir. Dr. Johnston-Lavis's plan of recording the azimuth of a movement by means of numerous electric contacts and "a pile of electromagnets" is a very retrograde step from the perfectly successful method, used in Japan, of resolving all horizontal movements into components along two fixed directions, these components being independently recorded in conjunction with the time.

Speaking of the use of the common pendulum as a seismometer, the author says that by using a short pendulum we may measure oscillations of short period, and by using a long pendulum we may measure slow earth-tiltings. Almost the reverse of this is the case. A short pendulum acquires, by earth movements of short period, a swing which cannot be distinguished from the movements we wish to measure, and whose extent depends on the accidental agreement of its period with theirs; but a short pendulum can be properly used to record slow earth-tiltings, with respect to which it is sensibly deadbeat. A long pendulum can be used to measure short-period movements; it can also be used (and its only advantage over a short pendulum is greater sensitiveness) to measure slow tiltings.

For vertical motion Dr. Johnston-Lavis condemns (but without giving any reason) my own and another vertical-motion seismograph—which theory and experience agree in proving

trustworthy—and proposes an instrument in which a weight drives a clock-train furnished with a centrifugal speed-indicator. The changes of apparent weight of the driver caused by the earth's up-and-down motion are to cause fluctuations in the speed of the driven train, which are to be recorded in conjunction with the time. The plan is, I think, new, but a less direct method of measuring vertical movement could scarcely be imagined. The fluctuations in speed will follow the changes of pull exerted by the driver with diminished amplitude and retarded phase, and superposed on them there will be fluctuations following no rule, due to inconstant friction and to mechanical imperfection of the train, as well as the continuous acceleration which follows the starting of the mechanism. To interpret the records would be altogether impracticable.

The design of a seismograph is a problem in applied dynamics which has of late years received a number of very satisfactory solutions. Of instruments capable of determining earthquake movements in absolute measure, and with reasonable exactness, there is now no lack; and it would be a pity if their wider employment were in any way retarded by the publication, on the authority of Dr. Johnston-Lavis, of suggestions which may fairly be said to lie outside the sphere of practical seismology.

University College, Dundee, October 27 J. A. EWING

The Sky-Glows

THE description of the sky-glows as seen by Prof. A. S. Herschel may justify an account of some seen near the University of Virginia, Virginia, during the past spring, from notes made at that time.

February 25.—For several days before this date there were (if one may so call them) the normal glows at and after sunset. On this day there was seen a single pink ray with well-defined edges, about 4° broad, perpendicular to the western horizon, reaching half way to the zenith.

March 24.—Ten minutes before sunset, the sun being behind a small cloud, the bright oval "glare" in the west, which preceded nearly all the after-glows, was seen with its centre at an elevation of 15° (all these heights are rough estimates). It was 10° in diameter, and was surrounded by a band of a hazy reddish ashen colour (this band was usually seen with the "glare") about 5° wide, which deepened in tint towards the horizon, and there spread out on each side of the "glare" so as to form a somewhat triangular support for it. At 6.30 the sun set. No colour had yet appeared on the eastern horizon. The "glare" now seemed almost triangular in shape, with the deepest ashen tints at the lower corners. As the sun descended, the "glare" diminished in intensity from the apex of the triangle. At 6.35 there was a ruddy colour on the eastern horizon, which spread in a triangular shape, apex upward, to a height of 25° to 30°, and at 6.40 was an exact image of the "glare" in the west, except that there were clear red tints instead of ashen, which were deepest at the lower corners of the triangle. The colour triangle then gradually rose from the eastern horizon, apparently following the sun, till at 6.48 the pink tint appeared in the western sky, increased in intensity, and was deepest at an elevation of 60°. The colour in the east was now gone. (Several attempts were made to observe the passage of colour across the zenith, but in no case was there success.) The western horizon was dazzling topaz-yellow, above the yellow pale blue, then faint pink to the deepest pink. The pink gradually descended toward the horizon, and when within 20° merged into the ordinary sunset colour at 7.0. The general phases of the glow were as follows:—Triangular ashen haze with oval "glare" in west, base of triangle on the horizon at sunset. Ten minutes later, triangular ruddiness in east, with base on the horizon. Another ten minutes, pink in the west. Ten minutes more, colour disappears. This succession was also noticed on March 15. On March 4 the glow in the west reached its most intense colour twenty minutes after sunset, but lasted twenty minutes, disappearing forty minutes after sunset.

On this evening (March 24) at 6.45, a cloud in the western sky, there being then no pink there, at an elevation of 35°, was coloured pale pea-green. This colour of the clouds floating at an elevation of 35° was seen on other days, while the clouds above and below retained their ordinary appearance.

March 26.—After the same phenomena as detailed in the last, even to the colour of the clouds, twenty minutes after the disappearance of the first glows, at 7.20 there was a pale rose-glow at an elevation from the western horizon of 30° to 35°, which reached almost to the Pleiades, of which six were then visible. This second glow lasted about twenty minutes, and seemed to descend to the horizon. It was almost identical with the first, but fainter.

March 29.—Same as preceding, without second after-glow; tints extended 60° to 70° from horizon.

These after-glows were noticed more or less during April, July, and September, and here in Cambridge during this month there have been several vivid displays. W. G. BROWN

Harvard College, Cambridge, Mass.,
October 23

I BEG to inclose you an extract from a letter lately received by me from my cousin, Mr. Leeming, in the hope that it may interest some of your readers. ELLEN A. DAY

Greycoat Hospital, Westminster, October 24

Extract from a Letter written by Thomas Leeming, Surgeon and Naturalist on Board H.M.S. "Gulnare," on the Admiralty Survey off Newfoundland

"*Galtois, Hermitage Bay, Newfoundland, September* 12, 1884

"There is one thing I have more than once forgotten to mention to you, that is, an unusual appearance in the sky there has been now for some months, which I think must be connected with the red sunsets of last winter. In the finest weather the sun has always about it a haze (not watery) extending some 20° or 30°, white in the day-time, but as the sun nears the horizon the sky has a pale salmon or ochrey tint. In the immediate neighbourhood of the sun, the sky is of a vivid whiteness. This appearance continues some time after sunset. I have tried more than once to reproduce this effect, with water-colours, but without success. Let me know if you have observed or heard of anything of the same kind. I may also mention that there has been until lately a great scarcity of stars; even on the fairest and darkest nights very few visible under the third magnitude, and the Milky Way scarcely to be seen at all. Things, however, are mending in this respect."

Peculiar Ice Forms

WALKING up from Chamounix to the Montanvert a fortnight ago, I came upon a form of ice which I think can hardly be of common occurrence, as I have not met with any description of it, and have only once before seen it, and then also on the same mountain side, and under similar conditions of season and weather.

The bank, which in this particular spot slopes at an angle of about 45°, and faces the north, is bare of vegetation for some 30 feet in depth, and 100 to 120 feet in length, the hillside above being clothed with moss, ferns, and the usual undergrowth. This bare slope was almost covered with a coating of ice nearly four inches in depth, and of very curious structure, being formed in four layers, the three upper layers each about an inch in depth, and the lowest, which rested on the soil, being from five-eighths to three-quarters of an inch. Each layer was composed of an aggregation of filaments or elongated crystals, one-sixteenth of an inch and downwards in diameter, and all of a length equal to the thickness of the layer, ranged side by side like organ-pipes or basaltic columns, and with pyramidal ends; the bottom points of one layer resting on the top points of the one below, so that the layers could be easily detached one from the other. The whole mass was pierced by vertical cylindrical cavities from half to a quarter of an inch or less in diameter, and in most cases penetrating from top to bottom, so that a pencil-case could be dropped through endways. A horizontal section presented somewhat the appearance of Gruyère cheese, minus the colour of course, and with the solid part showing the crystalline form described above.

The mass had evidently been pushed up from below, because, while the ice itself was perfectly white and colourless, it was covered at the surface by a layer of dirt which might very likely have concealed it from observation if it had not happened to be broken. There was a good deal of snow higher up—nine inches at the Montanvert—and the weather was fine, with bright sunny days and hard frost at night. This particular part of the bank was in shade all day, and hardly thawed at all. I imagine that the porous detritus forming the surface of the bank was underlain by hard rock (though it did not occur to me at the time to ascertain if it was so, and at what depth), and that the water

resulting from the melting by the sun of the snow above had percolated down to the hard substratum, along which it had run till it reached the place where the bare earth above it no longer protected it from radiation, and it then cooled and crystallised in this curious way, pushing itself up by expansion in so doing, each layer being the work of one night's frost. If this is correct, it is not difficult to understand what I assume to be the comparative rarity of this form of ice, since it would be seldom that all the necessary conditions would co-exist.

May I add, as the result of seven seasons' experience, that no one who has not tried it knows the charm of Switzerland in October. It is too late, of course, for high ascents, and the flowers are nearly gone; but an ordinary visitor, so long as he avoids the mists and clouds of the lowlands, by keeping at an elevation of three thousand feet and upwards, will find that the brightness and crispness of the air, the *enjoyableness* of the sunshine (which in August can at best be *tolerated*), the purity of the fresh snow, giving grandeur and beauty to lower heights which in summer are mere barren rocks, and the glory of the autumn colouring, not to mention the freedom from the plagues of heat, flies, and tourists, render October in Switzerland the most enjoyable month of the year. B. WOODD SMITH

Hampstead, October 31

The Blackness of Tropical Man

A DECISIVE paper on the subject would have to be prepared elsewhere, but Hindostan presents an excellent field for amassing information with regard to the effects of an extraordinarily powerful sun on the human frame's exterior. In a very interesting article in NATURE for August 21 last (p. 401), "Why Tropical Man is Black," the cause is set down to the nerves of the skin being one and all highly sensitive to light, the optic nerves being merely some of those of the epidermis highly specialised by long-inherited modification, and the necessity for placing over them a pigment which will absorb light. Otherwise the intense nerve vibrations from a light of double degree power would soon degrade the tissues of the individual and exhaust his vitality.

It would have been all the better if a little more had been said about the way in which a patch of dark pigment cells round the transparent skin of the nerve endings, to be exalted into a special sense, heighten the rates of vibration; or how the selected tissue, at the same time securing the transmission of heat, as the constant accumulation of heat waves behind it, throws the molecular constituents of the protoplasm "into the highest rates of vibration possibly obtainable with the means at disposal."

Before turning to the experience India affords, it has to be noticed that, taking the centre of Europe as the standard of whiteness, it is not only going south that the population becomes successively blacker, but that there is a dark-skinned tendency in the races lying in the other direction, towards the Polar regions. Besides this, exposure in the bright days of August on the moors in the British Isles has the effect of browning the white skin exposed to light, and making it on the face and hands for a short time only a shade lighter than the lightest Indians. This can only be by the solar rays producing pigment in the skin.

On the contrary, the experience of Europeans in India is that the sun there does not burn; if anything, it rather whitens them and pales the complexion. It is only on certain occasions, when the sun is obscured by rain-clouds, it is cool, and the diffused light is of a particular but unascertained actinic quality, that the skin of a European is sunburnt. One may ride all day in the hottest sun and have no trace of sunburning.

Also were light the sole cause of a protection for the skin being required, this would be supplied by the clothing Europeans invariably have, except on hands and face; and they would be placed in about the same favourable position as the natives, if not more so, as those of the latter of the class of labourers prefer working almost entirely without clothes.

What is dreaded by Europeans all over India, and extending into Afghanistan, is the "Indian sun," when it is elevated more than ten or fifteen degrees above the horizon; and it is chiefly the head which it affects, and which has to be protected by non-conducting materials, forming the strange head-gear of the tropics. The playing of the sun on the rest of the body is disagreeable, but not dangerous.

Light and heat are one and the same, so that the nerves of sight are only a select number of those with which the skin is full, higher strung; but it is noticeable that, though heat is felt by any nerves of the skin indiscriminately, they are insensible to minute differences of heat, or in the periods of the heat-rays, so that no sense, so to speak, is conveyed by them. That is—though, as we know, all objects reflect as many heat-rays of different kinds as they do visual rays—we are not conscious of their form by a reception and discrimination of the varying periods of the heat-rays; we do not consciously see by heat.

The effect the Indian sun has on European health, sunstroke being said to be the work of a few minutes, shows that the nerves of the skin are sensitive to some rays besides those of light. In fact, the sun's rays of Hindostan must contain rays not found in the sunlight of most other parts of the world, which moreover penetrate the European's white skin tissues and clothing, while the natives can let it beat upon their bared heads with complete impunity.

There has never been a sufficiently minute comparison made between the pure solar diffraction spectrum, from the lowest lines to the highest, of India and that in other countries, such as Great Britain, America, the West Indies, and Australia. In many respects the West India Islands are as tropical as the East Indies, but those who have resided in the former and coming to the latter declare there is some quality they feel in the Indian sun that is absent in the West Indies; they can wear a simple straw hat in the one place, but could not attempt it anywhere throughout India. If the spectra were juxtaposed, it would no doubt be found that groups of rays in some portion of it, whether at the red or the violet end, were present to a much larger extent in the light of the Indian sun than either in Australia or the West Indies. It is of the greatest importance, in order to clear up this question, as well as to science in general, that those who have the means and time should analyse the spectra and give the results.

The only test available is sensation at present, but this is unmistakable, because, in addition to the burning feel of 140° Fahrenheit, there is a peculiarly unpleasant sensation even in the shade, whether it is that of a tree, an umbrella, a thin tent, or even a walled room with a window, if there is no veranda. This can only come from invisible rays to which all but the thickest coverings are pervious, and which the skin and tissues admit freely.

European "colonists" are, happily for themselves, unknown in India, and the race would immediately die out, as it is only by frequent visits to temperate climates that a European can preserve health. But if they did exist it is open to doubt if a white skin would ever become black. It is commonly supposed that the Black Jins of Cochin are converted Hindoos. The difference that a change in dress and diet makes in these is singular, many being termed Portuguese, for example, who are pure natives descended from converts whom the Portuguese for the most part made forcibly.

As a rule, the higher the caste and the higher in the scale a native of India is, the whiter he is; and the lower the caste and hotter the mean temperature of the place, the blacker. But this is not invariably the case, as the outcasts who work in leather in Upper India are rather lighter than some of the Brahmans. However, latitude has most effect, and wherever the sun is hottest all the year round the blacker the natives, down to the equator of heat shown on the atlases. The configuration of the country, however, shows that the shades of colour are due to successive waves of conquest from the north, and the Northern Asiatics, who were nearly white at first, degenerate the farther south they come, and are unfit for labour. A blackness of skin, therefore, confers an immunity from the effects of the sun, so that those having it can labour in the heat in a way that would soon cause the lighter races to give in.

Black radiates quicker than white, and though black coats are by no means unknown to Europeans in India, who are as often in those as in coats of any other colour, the black skin of the labourer would throw off accumulated heat much more quickly than if white, and perhaps in a ratio worth calculating. This must be one of the reasons; and it may be noticed that the exterior of buildings is frequently tinted a slate colour with this view, in India, instead of being whitewashed.

Still a more ready dissipation of heat is not the only advantage imparted by a pigmentary blackness in the human skin; and it is to be inferred that the real protection consists in there being a few of the invisible solar rays of the spectrum in tropical light injurious to man, which nevertheless possess unusual

penetrative energy, and go through a thickness of what are ordinarily considered opaque substances, but which are intercepted by the contents of the epidermic pigment cells largely developed in the African, a little more sparingly in Hindoos, and not absolutely wanting in the sunburnt excursionist or sportsman in our own country.

The Australian will tell you that he has done hard work—in a shade temperature of 100°—in the sun in a light wideawake and not felt exhausted; while continuous labour of some hours in much less heat—75° in the shade and exposed to the sun—in Hindostan would be simple destruction of the European's powers of exertion with all a Bond Street hatter could devise on his head. A. T. FRASER

Equator of Heat, India, October 1

The Distribution of Scientific Works Published by the British Government

I HAVE read Dr. Valentine Ball's letter in your journal of October 30 (p. 634) expressing his astonishment that the scientific Reports of the British Government are not presented to the leading American scientific institutions. It may surprise Dr. Ball to learn that the Treasury recently refused to present one of the largest scientific libraries in Dublin with copies of the *Challenger* Reports on the ground that their "free list" was too limited! G. F. B.

A NEW METHOD OF HEATING IN THE REGENERATIVE GAS FURNACE

DURING the present age, which may be called that of Electricity, the sister science of Heat is not receiving so much attention at the hands of the natural philosopher as it did formerly. But still there remain some scientific men who are giving a life-long attention to it MM. Hirn and Berthelot in France, Herren Clausius, Helmholtz, and Frederick Siemens in Germany, Mr. Joule and Sir William Thomson in this country. During the late Sir William Siemens's lifetime, the one brother worked here in the science of Heat, the other in Germany, and the work of both was applied everywhere; now Mr. Frederick Siemens works alone, and, from the recent evidence of that work, it promises to play an important part in the economical application of fuel. Mr. F. Siemens has recently had an opportunity given him of bringing his views forward in this country, having read a paper at the Chester meeting of the Iron and Steel Institute on a new method of heating in the regenerative gas furnace, in which he treated the practical side of the question, whilst in the discussion of the same paper he gave his views on the theory of the subject. Mr. F. Siemens's investigations have led him to the conclusion that combustion can only be perfect, and be maintained perfect, if the space in which it takes place is sufficiently large to allow the gases to combine out of contact with solid materials. Having proved by actual experiment that solid substances interfere with the formation of flame and that flame injures solid substances with which it comes in contact, he brings forward an hypothesis to account for the phenomena. According to the electrical hypothesis, which Mr. Siemens prefers, flame is the result of an infinite number of exceedingly minute electrical flashes, the flashes being due to the exceedingly swift motion of gaseous particles, and a solid body which opposes itself to these flashes is cut by them, whilst, the motion being more or less arrested by the solid body, the flame is damped.

Another important deduction from these investigations is that combustion should be considered in two stages or periods, which may be respectively called active and neutral. In the first the purely chemical combination of the gases takes place, during which, as soon as the temperature of ignition has been reached, the whole of the heat of the highest possible intensity is produced, of which a large portion is given off by radiation, whilst in the second the temperature having fallen in the proportion of the heat given off by radiation, the remainder of the heat which is no longer of an active character, is best transmitted by conduction. For the purpose of utilising this portion of the heat, as well as for raising the temperature of the gas and air before combustion, the regenerators are requisite which form an essential feature of all furnaces worked at an intense heat on the Siemens principle, care being taken to design the furnace so that the gases shall have combined perfectly before the products of combustion are allowed to pass away.

Mr. Siemens in applying his investigations to practice insists that flame must not be allowed to impinge upon bodies to be heated, but must simply heat the bodies by radiation, and furnaces must be so constructed as to allow the flame to develop out of contact, not only with the substance on its bed, but with the walls and roof of the furnace itself; it thus follows that large furnaces must replace small ones, and to meet the objection that the loss of heat into the atmosphere must increase in the proportion of the area of the furnace, Mr. Siemens explains that the heat developed in the furnace increases in a much larger ratio than its increase in area, because flame radiates in every direction from every portion of its entire volume, while a solid substance radiates from its external surface only. The details of construction of metallurgical and glass furnaces and of steam-boilers are given in the paper in question, and need not be considered here; the main point is that furnaces heated on the radiation principle have been proved both in Dresden and at Landore to have been economical of fuel, whilst the saving in the materials treated from reduced oxidation and in the construction of the furnace has been found to be very great.

There is another point of view of this important question which is daily demanding and commanding more attention, and that is the abatement of the smoke nuisance. As is well known, smoke is but incomplete combustion, and the only way to get rid of it is not to produce it. Mr. Siemens insists that this can only be effected by not permitting flame to touch any substance whatever so long as it exists in the active condition; for, just as carbon is precipitated upon a glass rod put into an ordinary gas flame, so is it with any flame whatever its temperature; but the greater the difference of temperature between the flame and the body brought into contact with it the greater will be the amount of smoke produced. Mr. Siemens tells how in Dresden he succeeded in extending his works, without the production of smoke, by the application of the system of heating he recommends, and trusts that here also not only may smoke be abated, but that the public may also derive benefit by manufacturers being able to supply goods at cheaper rates owing to being able to economise their fuel and the material heated within the furnaces as well as that of which the furnaces are constructed.

THE PRIME MERIDIAN CONFERENCE

THE greatly extended and ever increasing intercourse, both commercial and scientific, which has grown up between different nations in modern times has naturally caused especial attention to be drawn to the question of assimilation of the different systems of reckoning employed. Weights and measures and money have been already dealt with more or less successfully, but always with steady advance in the direction of unification. More recently, and in like manner because of practical difficulties and inconveniences, unification of the methods of counting longitude and time has in its turn become a question pressing for solution by the establishment of some international agreement in regard to all matters relating thereto.

The subject became first systematically discussed at the Conference of the International Geodetic Association

held at Rome about a year ago, and the recommendations then formulated have since been further considered at a special International Conference recently assembled at Washington, the delegates at which, in some cases scientific men, in others the ambassadors accredited to the United States, were instructed by their respective Governments specially for the settlement of the questions of a prime meridian and universal time. Their final recommendations on the principal points involved are now before the world.

Unlike the related question of weights and measures, that of time becomes to a great extent simplified by the circumstance that no assimilation of units is necessary, since in the reckoning of time there exists one natural unit which already all nations alike employ, that of the solar day, divided in all centres of civilisation into twenty-four hours, each hour into sixty minutes, and each minute into sixty seconds, and reckoned generally from midnight to the midnight following. In the business and concerns of any single centre no anomaly arises, but if we travel to the east or west of our centre, say from Greenwich, we change—not our manner of counting time—not our unit—but only the zero from which we begin to count, that is, midnight in our new position will occur at a different absolute time. Thus midnight at Paris occurs nine minutes of time before midnight at Greenwich, and this difference between the natural time of the two places is their difference of longitude.

The practical navigator carries with him charts on which longitude is marked as reckoned from some particular meridian. Whilst some nations use the Greenwich meridian, others employ that of their own capital city or observatory, so that longitudes become differently reckoned on the charts of different nationalities. This, as regards practical navigation and in many questions of geography, was one inconvenience.

For many years all clocks throughout Great Britain have been regulated to Greenwich time. This causes no appreciable inconvenience in other parts of the country, because, on account of its small extent in the easterly and westerly direction, the natural time at any place (as referred to the sun) differs so little from Greenwich time that no violence is done to our conceptions of morning and evening as referred to the clock, whilst the advantage of having one standard time throughout the country is, in these days, enormous. Similarly the time of Paris is used in France, and so on. In the United States of America a more natural division into sections has been made, each having its own standard time, about which we shall have more to say further on. The standard time thus used throughout each particular country or section of country, whilst satisfying entirely internal needs, fails, on account of the difference existing between the standard times of adjacent countries, to meet international requirements, not only in questions of scientific interest, but also in matters commercial. The standard time counted in any district must continue to regulate its civil affairs, but for the efficient control of those of international concern, such as the railway, telegraphic, postal, and steamship services, an extension of the same principle to the whole globe by the establishment of some system of universal time, for use in conjunction with local standard time, became very desirable, for although such universal time could not be suitably employed in the ordinary way, the importance of its adoption in matters of international interest had become abundantly apparent. One other point. In civil affairs the day is counted from midnight, whilst astronomers count from the noon following, rendering troublesome conversions from one system to the other frequently necessary. These were other questions requiring consideration.

Clearly therefore the time had come for promoting a better understanding on points of this kind. The recommendations of the Roman Conference briefly stated were, that the initial meridian should be that of Greenwich, corresponding to the point midway between the piers of the Greenwich meridian circle, since such meridian fulfilled all the requirements of science, being already that most used and best likely to be generally accepted; also that longitude should be counted from the meridian of Greenwich in one direction only, from west to east, that is to say, the longitude of Berlin would be 0h. 54m., and that of Dublin 23h. 35m. The Conference further recommended, for purposes for which universal time would be convenient, that the universal day should commence at mean noon of Greenwich time, and be counted from 0h. to 24h., as was proposed in America in the year 1879 by Sandford Fleming and Cleveland Abbe, a proposition which had received the support also of well-known astronomers. It may be added that a proposition to assimilate the astronomical day with the civil day, and adopt it as the universal day, being scantily supported, was lost.

So far as regards the Roman Conference. Their proposals served to indicate the points requiring consideration, so that, attention having been thus directed to the whole question during the year since elapsed, the delegates attending the recent Washington Conference had full opportunity of forming deliberate opinion thereon. We are not yet in possession of the full discussions of the Conference, but we know their decision on all essential points. The recommendation of the Roman Conference that the meridian of Greenwich should be the universal prime meridian was confirmed. But on the question of reckoning longitude the Conference resolved that it should be counted from Greenwich in two directions up to 180°, the east longitude to be *plus*, and the west longitude *minus*, in this particular departing from the recommendation of the Roman Conference. The Washington Conference also disagreed with the resolution of the Roman Conference in regard to universal time, declaring the universal day to be the mean solar day to commence for all the world at the moment of mean midnight of the initial meridian, coinciding with the beginning of the civil day, and to be counted from 0h. up to 24h., a proposition which, as already mentioned, had been debated at the Roman Conference. Protocols were approved which will be made the basis of an international convention fixing Greenwich as the prime meridian.

Practically, therefore, the recommendations are:—

(1) That the prime meridian be that of Greenwich.

(2) That longitude be counted from this meridian in two directions up to 180°, calling east longitude *plus* and west longitude *minus*.

(3) That the universal day be the Greenwich civil day, commencing at midnight and reckoning from 0h. up to 24h.

After full discussion at two Conferences we may believe that, regarding scientific requirements on the one hand and practical considerations on the other, the conclusions arrived at are the best which, under the circumstances, were possible. We may now proceed to consider in various ways their practical bearing.

First, as affecting matters nautical and geographical. By the adoption of Greenwich as the prime meridian (which, if that of any one place were to be selected, was clearly from its extensive use the one which had by far the strongest claim to consideration), and by the retention of the system of counting longitude east and west up to 180°, all British maps and charts (already extensively used by most other nations) and all tables of longitude as hitherto prepared remain still in harmony with the recommendations of the Washington Conference. And since foreign nations thus so largely use charts which refer to Greenwich, the use of this meridian is likely in time to become universal. This being so, some labour of calculation might also be saved, for, considering that large portions of the existing astronomical and nautical

ephemerides of different countries are prepared mainly for the purposes of navigation, and that these ephemerides are calculated generally for different meridians, should charts on which longitude from Greenwich only is counted come into universal use, such separate calculation would become unnecessary. A certain uniformity has already been arrived at, our own *Nautical Almanac*, the American *Ephemeris*, and the German *Nautical Almanac* being all alike calculated for the Greenwich meridian, with the result, however, that now a mass of information for navigators—practically identical information—is repeated in three separate works. This hardly saves labour, and it seems not unreasonable to suppose, as regards the needs of navigators, that one book might in some way be made to serve for all.

It may be remarked that the counting of longitude in both directions up to 180° instead of continuously from 0° to 360° has, as regards navigation, advantages. Because, when counted in both directions, a navigator or traveller, in journeying round the world and changing his reckoning of longitude from east to west, or from west to east, as the case may be, at the same time that he makes the change of one day in his date (of course somewhere near the 180th degree of longitude) will always correctly produce the Greenwich date, necessary when the *Nautical Almanac* has to be referred to, by simple combination of his local time and longitude, whereas if longitude be reckoned from 0h. to 24h., and the navigator makes, as before, the change of one day in his date in the usual way at or near the 180th degree of longitude, which he must do if his date is to be in harmony with that of the countries which he will next approach (America if voyaging east, Australia if voyaging west) it will be necessary, when between longitude 0h. and 12h. west, after subtracting the longitude (always east) from the local time, to further add one day, in order to produce the correct Greenwich date. It will be understood that a chronometer, though showing Greenwich time, does not indicate the *day*, only hours and minutes, &c., so that a voyager has to depend for the correct Greenwich date on his own numeration of days and a proper consideration of his longitude.

Then as regards the question of universal time, first in relation to our own country. Greenwich mean solar time, or Greenwich time reckoning from midnight and counting from 0h. to 24h., being adopted as the international universal time, is such as is shown on all railway clocks throughout Great Britain, excepting that the railway clocks require twelve hours to be added to their indications during the afternoon hours, that is, 1h. railway time is 13h. universal time, and so on. Thus the time of any circumstance or phenomenon occurring in Great Britain will be properly given in universal time by dropping the suffix a.m. or p.m., and in the afternoon adding twelve hours. October 20, 9h. a.m., and October 20, 3h. p.m., become in universal time October 20, 9h., and October 20, 15h. But independently of this the counting of hours from 0h. to 24h. is desirable also in civil affairs generally as being in itself explicit, and rendering unnecessary the distinguishing a.m. and p.m. If clocks, when convenient, were constructed so as to indicate hours in this way, instead of counting from 0h. to 12h. twice over, it would tend to familiarise people with the 24-hour system without at all forcing its use; or the division into twelve might be retained in clocks and watches, and two sets of hour figures engraved. The use of the system will, however, extend on account of various practical advantages. The plan could be introduced with benefit into railway time-tables, especially those dealing with long routes, in which the distinction between morning and afternoon is far from explicit. Morning hours would be 0, 1, 2, &c., afternoon hours 12, 13, 14, &c.

In other countries in which, as in England, the standard time employed is that of some one city or observatory, such time similarly reckoned from midnight, and counted from 0h. to 24h., would be used for all internal affairs. But to give the epoch of any occurrence in universal time it would be necessary to subtract from the time noted the longitude east from Greenwich of the city or observatory whose time is used, or add thereto the longitude west.

Whilst it is absolutely necessary for the regulation of the internal affairs of a country that the time of one meridian should be employed throughout, as in Great Britain, it is also important that the time so used should not be violently out of joint as it were with the natural day. In our diminutive Great Britain no inconvenience arises, as has been mentioned; but in America, owing to the vast extent of the country in an easterly and westerly direction, it becomes necessary to make some arbitrary division. The railway companies of Canada and the United States, for regulation of the time on railways, have solved the difficulty in the following way:—Four different meridians being selected, those of 5, 6, 7, and 8 hours west of Greenwich, four separate districts are created, in each of which the time of one of these meridians is employed. By this means a great step in the unification of time has been made, because on this plan the minutes and seconds in each district are the same as the minutes and seconds of Greenwich time, and also therefore of universal time, the actual universal time in each district being at once found if required by simply adding 5, 6, 7, or 8 hours respectively to the local standard time.

But it may be asked, if the surface of the earth be divided into districts counting in each, for use in civil affairs, the time of some particular place or meridian contained therein, what is the particular need of universal time? The question has been already touched upon; but let us illustrate. A telegram received at a telegraph office in India in the afternoon for transmission to London would arrive in the morning, according to the local time reckoned at these places. Is there nothing here that for some considerations it might not be desirable to arrange differently? Would it not be useful to have the power of indicating universal time in conjunction with local time, if necessary? And so also in other affairs. And in matters of science, especially the observational sciences, the introduction of universal time for use when required would be in many ways beneficial. When an astronomer has gathered together for discussion a long series of observations of, say, a new comet, made perhaps at many different observatories, one of the first things that he has to do is to reduce the times of observation to that of one meridian. Again, observations of solar and other physical phenomena cannot be properly collated unless the times are reduced to one standard. Or, in magnetism, on the occurrence of a great magnetic storm, how much would the comparison of the records obtained at different places be here also facilitated by the use of universal time?

There might be some disinclination as regards fixed observatories to give results in universal time, because of the fractional difference of longitude. But in civil affairs, admitting the practicability of adopting the system inaugurated in America, of forming districts and employing as local standards of time secondary meridians distant from Greenwich by integral numbers of hours, as before described, the indication of universal time in conjunction with local standard time becomes a matter of great simplicity. Objection may be made to the system because of the variation, amounting to half an hour, which would exist, between the natural day and the clock time employed, at the extreme borders of the districts so formed, but the Greenwich time long used in Cornwall differs (without reckoning the effect of the equation of time) twenty-three minutes from the natural time without inconvenience arising. Indeed, taken in conjunction with what has been done at the Washington Conference, the

scheme is, outside of the Conference, the first really scientific step that has been taken in the practical unification of time throughout the world. Whether the number of meridians might be doubled is perhaps a question, but, as it stands, the scheme is extremely simple. For since the minutes and seconds counted in the several districts are the same as the minutes and seconds of Greenwich or universal time, the mere addition of another hour hand to the clocks in common use, placed in the proper position and travelling with the ordinary hour hand, would enable either local standard time or universal time to be read off at pleasure from the one clock. The ordinary hour and minute hands might be black and the additional hour hand of a lighter colour, in which way sufficient distinction would be produced. Such clocks should show hours from oh. to 24h. Or the conversion might be made in other ways. Referring to the American division before described, all entries might be distinguished as "local standard time," and a precept added to indicate that, to obtain universal time, 5, 6, 7, or 8 hours must be added, as the case may be. Or denoting the times as "standard times on the 5th meridian west," &c., the variation from universal time is at once shown. The reader will probably now have grasped the special merit of this system, the readiness with which either local time or universal time can be together indicated.

It may be interesting to show how the American plan of division into districts defined by hourly meridians would work if applied generally to the countries of the world. A scheme in regard to some of these countries is herewith annexed.

Countries	Longitude from Greenwich of meridian to be employed for local standard time	Local time at which universal date changes
Great Britain, France, and Spain	oh.	Midnight
Norway, Sweden, Germany, Austria, and Italy	1h. east ...	1h. morning
Western Russia, Turkey, and Egypt	2h. ,, ...	2h. ,,
Western India	5h. ,, ...	5h. ,,
Eastern India	6h. ,, ...	6h. ,,
Western Australia	8h. ,, ...	8h. ,,
South Australia	9h. ,, ...	9h. ,,
Victoria, New South Wales, and Queensland	10h. ,, ...	10h. ,,
New Zealand	12h. ,, ...	Noon
California	8h. west ...	4h. evening
Eastern America (Washington)	5h. ,, ...	7h. ,,

In east longitude decrease, and in west longitude increase, the local standard time by the hours of longitude to obtain universal time.

The scheme in fact resolves itself into adopting in any country the time of the nearest integral hourly meridian. Russia would become divided in some such way as America. In each case the minutes and seconds of local standard time would be similar to those of Greenwich or universal time, change of the hour, according to the precept given at the foot of the table, converting the local standard time at once into universal time. We are quite aware that a scheme of this kind can scarcely be expected yet to take practical shape, but it seems well to point out generally the direction in which with the least inconvenience a satisfactory solution of the problem of counting universal time in conjunction with local time may be possible.

The right hand column of the preceding table indicates, in regard to the universal day proposed by the Conference, the hour of the local civil day at which, in the several districts, the universal date would change, the civil date of course changing at midnight. It will be remarked that in all countries in east longitude as far as Australia, the change of universal date (following that of the same civil date) takes place generally in the morning hours, before the business hours of the civil day, the universal and civil dates being then in accord until civil midnight. In America the universal and civil dates are in accord from civil midnight until towards the next evening when the universal date changes (before change of the same civil date). In all these cases the change of universal date occurs at an hour well away from business hours. Only in New Zealand would there be inconvenience, the change of universal date occurring at civil noon, twelve hours after change of the same civil date. Knowing approximately the local time at which the universal date changes, a clock fitted with an additional hour hand in the way described would indicate at once the precise time of change.

The resolution of the Washington Conference further expresses a hope that as soon as practicable astronomical and nautical days may be arranged everywhere to begin at mean midnight, which would simplify any desired conversion into the proposed universal time. Passing by the nautical aspect of the question we may remark, that astronomers as a rule count their mean solar day of twenty-four hours from noon, commencing twelve hours later than the civil day of the same date, and the day is thus understood in all published observations and astronomical works. There is another consideration, somewhat fanciful perhaps, that astronomical observations being taken mostly at night it seems objectionable to make a change of date at midnight in the middle of a series of observations; but this carries now with it much less weight since attention to solar phenomena has so increased observation by day. It was perhaps felt at the Conference that the local civil and astronomical days should correspond as a matter of convenience in itself, and as simplifying the relation of both with the proposed universal day, thus promoting the use of the latter as might become convenient, either in civil or scientific affairs. To effect such correspondence, one of the days had to be altered, but since any proposition to change the local civil date at noon could not be seriously entertained, it was better that the astronomer should assimilate his day with the civil day. Indeed it was formerly the practice in France to employ the astronomical day, commencing at midnight, in the construction of planetary and lunar tables.

The proposed change in the time of commencement of the local astronomical day will involve some present awkwardness from the circumstance that the different astronomical ephemerides are calculated for astronomical time as hitherto reckoned, in addition to which our own *Nautical Almanac* is prepared several years in advance. Temporary inconvenience more or less there must be, but the new reckoning, when fully established, will be found to possess some distinct advantages. As concerns the Royal Observatory at Greenwich, the Astronomer-Royal proposes to adopt the recommendation of the Washington Conference by commencing on January 1 of next year to count the astronomical day from the midnight preceding the nominal civil date, thus bringing the Greenwich astronomical day into correspondence with the Greenwich civil day, which is the universal day of the Conference; he proposes further to alter the indication of the public clock at the entrance gate of the Observatory, so that oh. of the clock shall also commence with midnight: all being counted from oh. to 24h. The time reckoned within the Observatory and that shown on its external wall will then be in accord. So far the astronomer. If, in addition, the civilian would relinquish the use of the confusing a.m. and p.m., and instead count the hours also from oh. to 24h., beginning with midnight, all parties would then be using the same system for reckoning both days and hours of the day.

WILLIAM ELLIS

THE ILLUMINATED FOUNTAINS AT THE HEALTHERIES

NOW that the most successful of International Exhibitions has been closed, we are able to give the final result of the accumulated experience that has been obtained in connection with the working of the illuminated fountains, which excited unqualified admiration. Even on the last night we believe new experiments were tried, and next season these fountains are likely to be finer than ever.

"I wonder how it is done?" This was one of the remarks most frequently heard in the dense crowd which nightly surrounded the large fountain at the Health Exhibition, watching the many party-coloured jets of water as they rose and fell with an ever-varying combination of brilliant hues. It is believed that an account of the means employed to produce these gorgeous and novel effects, and of the way in which the water and lights were managed, cannot fail to interest our readers.

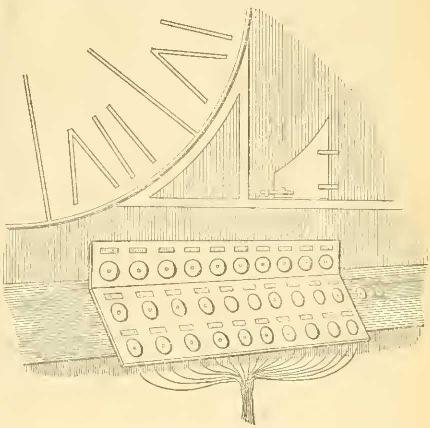
The water-supply is obtained from the West Middlesex Water Company by means of a nine-inch main, which is connected to one of their mains in Kensington Gore. As the water is paid for according to quantity used, it has to be measured, and in order to effect this with as little loss of pressure as possible, the water is passed through three eight-inch Tyler meters, which are to be seen at the north-west corner of the grounds in the vicinity of the fountains. These meters are connected at each end by a four-way junction piece to the nine-inch main, and they were afterwards supplemented by a twelve-inch one on a separate branch. From the four meters the main passes under the water into the central chamber in the basin, and it there branches into three pipes, two of nine inches diameter, and one of six inches. The two nine-inch pipes go round the two sides of the chamber, which is twenty feet square, and are connected together at the opposite side, thus forming a loop round the chamber. Off this main are taken the supplies to the four rings of jets in the basin, and also for the jets on the top of the chamber, each ring having two supplies at opposite sides in order to equalise the pressure. The third branch, which is in direct continuation of the main from the meters, is gradually reduced to three inches, and supplies the centre jet only.

All the supplies are furnished with screw valves worked by hand wheels. The jets on the top of the chamber consist of the centre jet and four other jets placed at the four corners; each of these jets is surrounded by a ring of twelve small jets, and there are also four dome and convolvulus jets placed between the corner jets. The supply to the four corner-jets is controlled by a plug-valve, so that they can be rapidly turned on and off. It is by this means that the jumping of the centre-jet is produced, the momentum of the water flowing through these jets being sufficient, on the sudden closing of the valve, to jerk the centre jet thirty feet higher than the point which it reaches from the pressure of the mains alone.

In order to light up the various jets on the top of the chamber, five circular sheets of glass two feet in diameter are let into the flat roof of the chamber, one under each jet. The pipes leading to these jets go through the roof close to the edge of the glass, and are then bent over it and upwards again, so as to bring the jet itself exactly over the centre, and it is under these panes that the lighting apparatus is placed. This consists of a simple bracket lamp with rack and pinion worked by hand for feeding the carbons, and a third-order holophote lens twenty-two inches in diameter. The carbons are placed at an angle of about 20° with the horizon, and the bottom carbon is the positive one, in order to have the crater turned upwards. The axis of the top carbon is also slightly above that of the lower one, although parallel to it. The carbons are eighteen millimetres in diameter, and the current is about sixty amperes. The five lamps are connected in parallel. Each lamp is inclosed in a case to protect the men from the light. Above each holophote is placed a frame with five grooves, in which run five frames containing the different coloured glasses by which the various colours are produced.

When first erected the jets were provided with glass bottoms, and a small lens was placed above the holophote so as to concentrate the centre portion of the ray on the interior of the rising column of water. It was however found that this arrangement considerably reduced the height of the jet, on account of the eddies produced in the chamber at the bottom of the jet, and also diminished the amount of light thrown on the spray, and it was therefore abandoned.

The principle of interior lighting of a stream of water was applied to three jets from the top of the Corinthian columns erected on each side of the statue of the late Prince Consort, and for this purpose two two-inch pipes were taken up each column, and connected with a cistern from which issue three jets, each illuminated from behind



by an electric lamp with twelve-millimetre carbons and twenty-ampere current. These lamps are in parallel arc on the same circuit as the large lamps in the centre chamber, suitable resistances being inserted. It was found that the two supplies provided did not allow of a column of water of sufficient diameter being thrown from each jet to prevent its being broken up by the wind, and as it was impossible to increase the supply while the Exhibition was open, these effects were rarely used. The current for these eleven lamps, amounting to 420 amperes, is generated by a compound shunt-wound Simens B_2 machine placed in the electric light shed. The armature of this machine is built up of copper strips with spaces between, and is thus especially adapted for the work it has to do, which at times is very severe, as, the lamps being hand-fed, the arc is not struck as rapidly as in an automatic lamp, and the machine is therefore short-circuited for an appreciable space of time on starting or relighting any lamp. The electromotive force at the machine is eighty-four volts. From the machine the current is conveyed to the small hut near the meters by two well-insulated cables of nineteen strands of No. 12 copper wire, and from the hut it is distributed to the island lamps by an insulated cable of nineteen No. 10 wires

inclosed in a lead pipe, and to the columns by two cables of seven strands of No. 12. A separate return cable runs from each lamp to the hut, where it is connected to the necessary resistances, made of strip iron, and from there back to the dynamo through two cables of nineteen No. 12's. There is altogether very nearly a ton of copper in the various leads and branches. Besides these leads the centre chamber is connected to the circuit of the Sun light machine, so that, should any accident occur to the main circuit or machine, Sun lights could be substituted for the hand lamps.

As the falling spray cuts off the light from below when the jets are at their highest, a light is placed in the top of the clock tower to illuminate the top of the jets. This light is a focus-keeping Siemens automatic lamp, and takes a current of fifty amperes, supplied by a small Crompton-Burgin machine. The lamp is inclosed in a cast-iron casing swung on trunnions, and in front of it is a fifth-order holophotal lens by Messrs. Siemens.

The various coloured glasses are fixed in frames or sashes arranged with counterweights, in the same way as an ordinary window. Some of the best effects of colour are also obtained by sheets of gelatine, of which a large number are fastened end to end, and fixed to two rollers, so that they can be wound from the one to the other, and thus passed through the beam of light.

As the men in the centre chamber cannot see the effects they produce, it is necessary to direct them from the outside, and this is effected by an elaborate system of electric bells and disks, which are worked from the clock chamber below the last-described holophote. In this chamber sits Sir Francis Bolton, with a treble row of "pushes" in front of him, all labelled, by touching any of which a corresponding disk or bell is worked in the island. There are four bells—a call bell, an "on" bell, an "off" bell, and a lamp bell—and two indicator boards with eight disks each, and one with four. One board is for the water valves, which are each painted a different colour, with the corresponding colour on the disk, and the second board for the coloured glasses over the holophotes. The disks on the small board refer to the corner lamps, and by their means Sir Francis can direct any colour to be placed over any one of the lamps by touching the push corresponding to the lamp and the push marked with the colour which he wishes to show. The working of the holophote at the top of the clock is directed in the same way.

EXPERIMENTS WITH COAL-DUST AT NEUNKIRCHEN IN GERMANY

DURING the course of the last summer the Royal Prussian Fire-damp Commission has carried out a series of experiments in the Saarbrücken mining district with the view of ascertaining the influence which coal-dust has, alone and in conjunction with fire-damp, in propagating explosions in mines. The apparatus and the mode of experiment were suggested by retired Bergwerks-director and Bergassessor Hilt, of Aix-la-Chapelle, who is a member of the Commission, and the results hitherto obtained have been of the most interesting kind.

The experiments are conducted at the Royal Coal-Mine, König, near Neunkirchen, where there is a blower of fire-damp at a depth of 131 yards below the surface. The quantity of fire-damp given off by this blower amounts to about 0·9 cubic foot per minute, consisting of 86 per cent. of light carburetted hydrogen mixed with air, &c. It has been in existence for the last two years. The fire-damp is brought a distance of 1200 yards in pipes, and collected in a small gasometer whose capacity is 176 cubic feet.

Dr. Ad. Gurlt of Bonn lately called my attention to the fact that over two hundred experiments made with this apparatus on a large scale had proved the correctness of my theory of great colliery explosions (*Proc. Roy. Soc.*, vol. xxiv. p. 354, &c.), and at the same time suggested that a visit to Neunkirchen would be of interest.

Accordingly I proceeded to the scene of the experiments on October 25, accompanied by Mr. Wm. Thomas Lewis, one of the members of the Royal Commission on Accidents in Mines, and we were met there by Dr. Gurlt, who had travelled from Bonn for the purpose, and by Herren Prietze, Nasse, Margraf, and Kreuser, directors and assistant-directors of König Grube and other Royal mines of the neighbourhood. Herr Margraf, under whose superintendence all the experiments are and have been made, has most kindly furnished me with a detailed description of the apparatus and of the experiments witnessed by Mr. Lewis and myself, and I am glad to avail myself of, and shall endeavour to reproduce, his account as nearly as may be, allowance being made for the difficulties of exact translation.

The experiments are made in a horizontal wooden gallery 167 feet long, closed at one end, and having a horizontal branch gallery 33 feet long standing out at right angles to it at a distance of 93 feet from its closed end. Both the main gallery and the branch consist of elliptical rings of double T-iron lined internally with planks 1·6 inch thick, which abut closely together and are grooved and feather-jointed lengthwise. The greater axis of the ellipse stands vertically, and is about 5 feet 7 inches long; the lesser axis is 3 feet 11 inches long. The main and branch galleries are both embedded in the pit-heap to such a depth that the rubbish is level with their top on one side and reaches to three-quarters of their height on the other side. Along the exposed part of the latter side there is a row of windows, thirty-two, in the main gallery, and three in the branch gallery, situated somewhat more than a yard apart. They are formed of sheets of glass about $\frac{3}{8}$ inch thick set in cast-iron frames. There are also a number of openings in the top of the main gallery, one of which, near the closed end, is an ordinary man-hole, which can be closed by a man-hole door like that of a boiler, and serves as a means of ingress and egress. The others are circular, about 9 inches in diameter, and are lightly closed with wooden plugs attached to chains, which act as safety valves. All these openings assist in the removal of after-damp after an explosion.

The closed end of the main gallery is sunk about 3 feet 9 inches into a block of masonry whose dimensions are 12 feet 4 inches long, 9 feet 9 inches wide, and 13 feet high. Seven cast-iron cannon, with a bore similar to that of a shot-hole in hard ground, are built into the block in the position shown in the figure opposite, so that their mouths are flush with the face.

There are two holes near the top, two near the bottom, and three in the middle, grouped symmetrically in relation to the two axes of the ellipse. The middle hole is 37 inches deep by 1·57 inch in diameter; the others are $31\frac{1}{2}$ inches deep by 1·37 inch in diameter. The axes of the two upper and of the two lower holes are placed in such a position that they form the angles of a four-sided regular prism whose apex is situated in the axis of the main gallery at a distance of 16·4 feet from the face. The axes of the three middle holes constitute a bundle of rays which meet at the same point as the last. Wooden hoops projecting inwards from the sides are placed at various distances apart in the main gallery within the first $65\frac{1}{2}$ feet from the face. By fastening cloth diaphragms to these hoops, compartments of various capacity can be formed, that of the first next the face being 705 cubic feet.

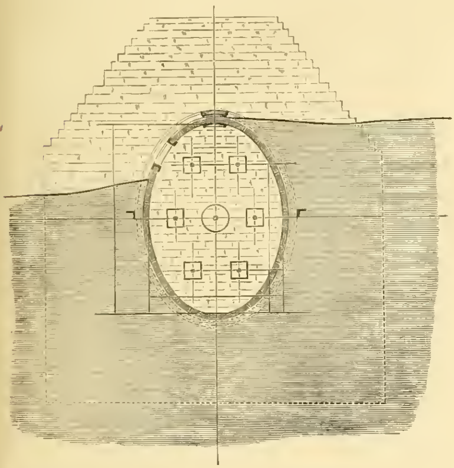
The shots are fired electrically with Abegg's fuses by means of an exploder made by Mahler and Eschenbacher of Vienna. The charge, which consists of 230 grammes, or about half a pound, of powder, occupies a length of 8·64 inches in the central hole, leaving room for rather

over 28 inches of stemming, and 11 inches in the other holes, leaving about 20 inches for stemming.

The coal-dust is strewn upon the floor of the gallery from the face towards the open end in a layer of about 1·17 inch thick immediately before firing the shots. The weight of dust in each ten yards of length is about thirty pounds. It has been found in practice that, notwithstanding the upward direction of their axes, the shots next the floor produce the greatest disturbance of the coal-dust and give rise to longer coal-dust flames than any of the others.

In all the experiments witnessed by Mr. Lewis and myself, *one shot-hole only*, namely, one of the two next the floor, was charged and fired. The charge consisted of 230 grammes of blasting-powder each time, and the tamping was damp clay. Both ends of the branch gallery were closed with a double board brattice 1·96 inch thick.

In the first experiment neither coal-dust nor fire-damp was employed, and the flame of the shot was seen through the windows to be a little over 13 feet long.



In the second experiment a length of 65 feet of the floor of the main gallery was strewn with coal-dust from Camphausen Colliery in the Saarbrücken mining district. The shot gave rise to a loud detonation, and the resulting flame filled the gallery to a distance of $88\frac{1}{2}$ feet. When the thick black after-damp had been drawn off by means of two of Korting's exhausters, placed over two of the safety-holes and worked with compressed air, it was found that the inner brattice of the branch gallery had been broken, and small globules of coke were observed lying on the surface of the remaining coal-dust.

In the third experiment a length of 130 feet of the floor of the main gallery was strewn with coal-dust from Pluto Mine in Westphalia. When the shot was fired, the flame traversed the whole length of the gallery with great velocity, and came out at the open end to a distance of 16 feet, being thus altogether 183 feet long. Notwithstanding the entire absence of fire-damp, this was a true explosion of the most violent kind, and the clouds of after-damp which streamed from every opening darkened the air in the neighbourhood of the gallery for two or three minutes. The brattice at the inner end of the branch gallery had not been replaced before this experiment, and the one at its outer end was broken into small fragments, some of which were thrown to a distance of 115 feet. The flame was also seen to emerge from the branch gallery to a distance of several yards. The coal-dust remaining on the floor after the explosion was covered with a sooty film, in which coke globules were found embedded.

The brattice at both ends of the branch gallery was now replaced, and the floor of the main gallery swept clean as usual. In the fourth and last experiment coal-dust from Pluto Mine was strewn on the floor for a distance of 65 feet from the face. A diaphragm of prepared canvas was fastened in the gallery at the point where the space inclosed between itself and the face amounts to 705 cubic feet.

A volume of $35\frac{1}{4}$ cubic feet of fire-damp was introduced into this space, and complete diffusion was effected by beating the air with cloths. The mixture of fire-damp and air thus obtained is not inflammable or explosive by itself, and shows a cap of only $1\frac{5}{16}$ inch high on the reduced flame of a safety-lamp. The firing of the shot produced a flame 190 feet long, accompanied by a report like a thunder-clap. The inner brattice of the branch gallery was broken, and drawn several yards into the main gallery, but the outer one remained intact.

Some idea of the great force of the two last explosions may be gathered from the following facts:—An ordinary mine railway, beginning on a level with the floor of the main gallery, extends away from its open end in the direction of its length, and ascending at an angle of 4°. An ordinary mine waggon, loaded with iron so as to weigh altogether $15\frac{1}{2}$ cwt., was standing on the rails at the mouth of the main gallery when the shots were fired. When the third shot was fired, it was driven up along the rails to a distance of 23 feet, and when the fourth shot was fired, it was literally hurled along the railway by the force of the explosion to a distance of $52\frac{1}{2}$ feet, being driven off the rails and running on the ground for the last six feet. The boards constituting the end of this waggon next the gallery were broken, but not torn off. A small beam 4 inches square, bolted across the rails at the mouth of the gallery, so as to form a stop for the waggon, was torn from the bolts which held it, and sent flying after the train. Lastly, a shower of stones and debris was raised by the blast which swept out of the mouth of the gallery, and some of the pieces carried upwards of 100 feet.

The foregoing facts appear to me to be well worthy of the attention of all who have any interest in the prevention of explosions in mines. W. GALLOWAY

FLOWERS OUT OF SEASON

THE untimely flowering of trees and shrubs, like the occurrence of the extraordinary gooseberry, is a subject which crops up at such regular intervals as almost to belie the epithet applied to it. Nevertheless, the very frequency of the comment is an indication that the matter is ill understood.

The ordinary time-rate for the production of new cells, new leaves, new flowers, and so on, varies as we see within wide limits. Equally obviously those limitations are imposed by the conjoint effects of inheritance and of external conditions, such as climate or food, or both. An annual plant rushes through its life in hot haste as it were: save and except in the seeds of such plants there is comparatively little building up or maturing of new tissues to be done, and proportionately still less stores of potential food to be accumulated. If, on the one hand, the requirements of such plants are less than in the case of perennials, their exigencies are, on the other hand, more pressing. What they take from the soil, or atmosphere, what power they derive from solar light and heat, must be got quickly or not at all. One illustration of this is afforded by the paucity of annual species in the Arctic regions or at high altitudes. Neither heat nor light is absolutely deficient in such situa-

tions, but the length of time during which they are available is too short to allow annuals to profit by a sufficiently large aggregate to enable them to mature their seeds. Before they can accomplish their purpose, they are overtaken by frost and their activity is put a stop to. The energy of perennials, it is true, may be checked in the same manner, but they have been enabled, before the evil day arrived, to lay up stores of nutriment available for use when the increasing heat and light of the following year shall once more quicken their activity. The work to be done is spread over two or more seasons instead of one, and the chances of success are thus correspondingly enhanced. But if we suppose the conditions to be uniformly and continuously favourable, the abrupt cessation of growth will no longer be manifest, the annual will cease to be an annual, the perennial will not die down in winter, the growing points of the buds will not incase themselves in scales, vegetation will be continuous. Such halcyon conditions find their nearest realisation in moist equatorial climates like that of the Malay peninsula and adjacent islands. But even there the realisation is not perfect. Something happens to disturb the balance; and even if the conditions are generally uniform there is always the idiosyncrasy of individual plants to form a disturbing factor. Again, such conditions, though favourable to the continuance of vegetation, are less propitious to the establishment of fructification. The formation of stem, leaf, flower, even of fruit, is one thing, the maturation of the seed and of the embryo-plant within it is another; and the conditions propitious to either are correspondingly different. The ripe seed makes in proportion larger demands on the plastic matters formed as a result of metabolism, and has almost invariably the same composition according to its species, but this cannot be said with equal truth of any other part of the plant.

Again, the conditions for growth, that is, mere increase in bulk, are different, in degree at least, from those which favour progressive development or metamorphosis. Speaking in general terms, it may be said that vegetation approaches its end where fructification shows signs of commencement. There is indeed no fixed line of demarcation to be drawn, but while morphologically there are gradations and intermediate forms, physiologically there are also transitions, and periods of instability. It is easy to understand how this happens, and how it is the divergences are not greater. These matters indeed partake so much of the nature of truisms, that some apology might almost be needed for insisting on them, were it not that they are absolutely essential for the due comprehension of the phenomena of untimely blooming.

It is also desirable to draw attention to the fact that there is naturally a wide range in the period during which vital activity manifests itself even in individuals of the same species, and as these individuals vary in colour, stature, &c., even when derived from the same stock, so others may vary in their "time-rates." This is specially noticeable in the case of the horse-chestnut, and is perhaps more often manifest in the form of precocious development in spring than in that of tardy growth in autumn. In most cases the plant has to attain a certain age before it produces flowers, but occasionally we find individuals so precocious that they are scarce out of the seed before they burst into flower. A cocoa-nut has thus been seen in flower while the husk of the fruit was still attached to it. Gardeners, according to their requirements, have freely availed themselves of these individual differences by selecting for perpetuation late or early varieties. The whole subject of the "chronometry of life," it may here be mentioned, formed the text of a valuable lecture by Sir James Paget, at the Royal Institution, many years ago.

Cases of unseasonable blossoming may be ranged under three heads, according as growth and development are: (1) prolonged beyond the ordinary time; (2) premature or manifested aforetime; (3) renewed after a short interval of arrest. Categories (2) and (3) differ in detail rather than in essence, as will be explained further on.

Taking the cases of continuous or prolonged growth first, it is easy to see that many of them are due to a continuance of favourable conditions. A long spell of summer without excessive heat or drought will insure a longer period of blooming; flower will succeed to flower so long as the weather and the natural changes in the tissues of the plant, according to age, are held in abeyance. How small are the exigencies of some plants in these matters may be illustrated by the fact that there are few days in the year when a daisy or a white deadnettle may not be found in bloom, at least in the southern half of England. It is necessary, however, to introduce some qualification, because one has only to look into one's garden to see that in spite of apparently favourable conditions many plants are not to be induced to continue blooming. Although in duration perennial, in the matter of flowering they behave as annuals. Something in their organisation forbids the prolongation of the blooming period. That this is so is at least rendered highly probable by the circumstance that the same reticence is exhibited under cultivation. As an illustration of an opposite character, may be mentioned the prolongation of the blooming period even under relatively adverse circumstances which has been brought about by the art and selection exercised by the gardener. Take roses, for instance, only one of many that might be cited. Our fathers had to be content with what we now call summer roses, roses of great beauty and exquisite fragrance, but which they must have wept to see "haste away so soon." Nowadays, the case is very different, there is a whole legion of so-called "hybrid perpetuals" marked in the catalogues of the nurserymen as H.P. By their agency a second crop of roses is assured, while some will continue in favourable seasons to expand their blooms in succession up to Christmas. This prolongation of the flowering season has been brought about by combining by means of hybridisation the robust qualities of European roses with the continuous blooming tendencies of the Indian rose. Many varieties of pear, the common laburnum, the Wistaria, Weigela, the hybrid *Berberis stenophylla*, some rhododendrons, currants (*Ribes*), exhibit this phenomenon, the flowers being produced on the ends of more or less prolonged shoots, as strawberries under like circumstances produce their flowers on the ends of the "runners" of the year.

The premature development of flowers in autumn has a better title to be called unseasonable, because the phenomenon is really due to the unfolding of flowers which, under ordinary circumstances, would remain passive till the following spring. There is not, as in the former case, a new formation or a continuous growth, but merely what the French appropriately call *fleuraison anticipée*. And here for a moment it may be allowable to call attention to an essay of Linnæus entitled *Prolepsis Plantarum*, little read nowadays, although based on facts, and containing much that is still worthy of consideration. For him a flower was a shoot with lateral outgrowths, a morphological conception that would still satisfy a German transcendentalist. But, further, this shoot and its outgrowths were supposed to represent the outcome of six ordinary years' work contracted into one. A flower was, according to this theory, a shoot in which the differentiation of parts instead of being spread over six years was hurried on and completed within one season. For Linnæus leaves represented the work of one year, bracts that of the following one, sepals of the third, petals of the fourth, stamens of the fifth, and the pistil that of the sixth year. It is not necessary to discuss the morphological aspects of this theory, but it is relevant to our present purpose because it emphasises the relation of leaf-shoot to flower—a relation enunciated about the same

time, and independently one of the other, by Wolf and by Linnæus, and thirty years before Goethe propounded a similar notion. Moreover, it brings into prominence not only the morphological relation of shoot and flower, but one manner in which the time of production of the shoot and of the flower respectively may be varied, a subject having an immediate bearing on the question of unseasonable flowering. If, says Linnæus (*Prolepsis*, § iii.), "a shrub which has been grown in a pot, and has borne flower and fruit every year, be transferred to richer soil in a hot-house, it will produce for many years numerous leafy shoots, but no fruit. From which it may be inferred that the leaves are produced from the same source whence the flowers previously sprang, and so in turn what now tends to form leaves would, by this agency of Nature, be converted into flower if the same tree were again placed in a pot so as to confine the roots; hence gardeners desirous of obtaining a more plentiful crop of strawberries, cut the fine roots of the plants in spring before they transplant them, in the hope that they will produce more abundant flowers and fruit." Here we see the same principle laid down as that upon which gardeners act when they wish to secure flower and fruit by cutting off the supplies, and thus making the plant, to a greater degree, dependent on the elaborated reserve stored up in their tissues. This is effected by growing plants in small pots, root-pruning, transplanting, ringing, and other processes, all of which tend to diminish root-absorption, and by disturbing the balance between it and other processes, to check vegetation, and in so far to promote the formation of flower. Charles Martins relates the production on a very large scale of inflorescence on the Agave, in Algeria, as the direct consequence of the excision of the leaf-buds by a troop of French cavalry, who hacked the plants with their sabres as they passed, and thus, by preventing or checking growth in one direction, stimulated it in another. In like manner I have seen flowers produced on the "suckers" of *Ailanthus glandulosa* when the plant was quite young, on the roots of *Pyrus japonica*, and on a sucker of Agave, as the result of injury, probably in all, certainly in some, of the instances.

The frequent production of flowers out of season on newly transplanted trees is accounted for in like manner. But many trees are flowering this autumn which have not been slashed with sabres nor moved by more peaceful weapons. One such tree, a horse-chestnut, I lately (September) saw, in which one limb, and one only, was full of young leaves and flowers, while the remaining limbs were fast losing their foliage. The reason for this partial production of bloom I was not able to divine; possibly it may have had some relation to injury to a certain portion of the root-system in more or less direct connection with the particular branch, but I have no evidence to offer in support of such a guess.

In speaking previously of one modification of unseasonable flowering dependent on activity protracted beyond the customary period, it was mentioned that the flower was in such instances developed at the ends of long slender shoots formed during the course of the summer. In such cases the shoot ends in a flower-bud instead of a leaf-bud as is usually the case. The conditions are no longer favourable for the extension of the shoot, and the energy of growth is diverted to the production of flower. But in the laburnum, in many fruit-trees, such as the apple and pear, the fruits are normally borne on short thick branches called by the gardeners "spurs." These are very interesting physiologically, as possessing intermediate transitional characteristics, such as those before alluded to, between vegetation and seed-production. In form, these spurs are short and thick, with very narrow interspaces between the leaves, and they bear a cluster of buds which ultimately all develop into flowers, or in which the central and terminal one is a leaf-bud. Internally these spurs are soft and spongy, with a great preponderance of cellular over fibro-vascular or woody tissue. The cells are moreover filled with starch. We have evidently here got to do with store-places, analogous to that furnished by the tuber of the potato and other formations, in which food, or matter capable of conversion into food, is stored up for future use at the growing points; in this case for the formation of fruit. Flowers are occasionally produced on these spurs out of due season: the flower-bud destined for a following season bursts into activity this year, affording an instance of a true *fleuraison anticipée*; but more often, according to my observations, when an untimely flower is produced (especially in the apple), it is from the development of a flower in the central bud of the spur, which is usually a leaf-bud as above stated. In such a case, then, we have not only an alteration in the character of the bud, but a change in the period of its expansion. A converse illustration to that just given is afforded by a case recorded by Mr. Berkeley, in which a bud of a walnut, which in the ordinary course of things should have produced a female inflorescence in the following spring, was developed in the autumn as a leafy shoot.

Renewal of growth after temporary arrest, "recrudescence" as it is sometimes called, occurs normally in the pine-apple, Eucomis, Metrosideros, and other plants. Abnormally, I have met with it in *Cytisus nigricans*, the common wallflower, Œnothera, and many others. It hardly differs from the first category mentioned in this note except in the fact that the new growth is the direct continuation of the old and not an entirely new lateral formation. It differs from the terminal bud of a "spur," in that the latter is normal as to position even if developed out of season, whereas in the class of cases now under consideration the activity of the growing point, which usually ceases with the development of the last flower, is exceptionally continued.

One other circumstance deserves mention, and that is the rarity with which true fruit, or at least ripe seed, is produced as a result of these untimely flowers. Sometimes, of course, ripe seed is produced; a plum is before me as I write the seed of which is as perfect, to all appearance, as that of the first crop could have been. But in the majority of the pears and apples which come under one's notice at this unseasonable period, the fruit is there (in the popular sense), but the core, which is in a botanical sense the true fruit, is absent, or, if present, the seeds it contains are usually abortive. Botanical readers will readily see the morphological reason why, and physiologists will recognise that in such cases the deviation from the ordinary course is not so great as it appears upon the surface, and the action of the "environment" is not so potent as it appears to be at first sight.

To sum up: these cases of unseasonable flowering appear to be due either to continuous growth and development, to renewal of growth after a longer or shorter period of arrest, or to the development of a flower-bud in the place of a leaf-bud. What produces these changes? To this no more precise answer can be given than has already been afforded. The absolute nature of the change, structurally and morphologically, depends upon the nature of the inducing causes, and varies accordingly; the degree of change may depend simply on the increased or prolonged intensity of action of the same causes which promote natural growth.

MAXWELL T. MASTERS

NOTES

THE Washington Prime Meridian Conference closed on November 1. Protocols were approved, which will be made the basis of an international convention, fixing Greenwich as the prime meridian.

MANCHESTER is determined to have the British Association in 1886, and its invitation will almost certainly be accepted.

THERE is no truth in the statement which is being repeated so often that Baron Nordenskjöld intends to lead an expedition into the Antarctic regions.

IN a letter from the Sagastyr Meteorological Station on the Lena, dated March 20, and appearing in the last issue of the *Izvestia*, M. Yurgens informs the Russian Geographical Society that twenty-six years ago a mammoth was discovered in the delta of the Lena, twenty-three miles from the station. Its head and tusks had already been taken away by a Russian merchant at the time of the discovery of the body, and the Yakuts of the neighbouring settlement have taken a leg, several ribs for making spoons, as also parts of its skin for straps, and fat for painting their sledges. The body is lying on the right side in the lower part of a crag of alluvial deposits thirty feet high. The interior is said to be quite safe. Dr. Bunge went to the place pointed out by the Yakuts, and undertook regular excavations for a distance of 350 feet, the expedition not being sure that the Yakuts have shown the right place: they consider it a sin to take from the earth what it does not give itself. The work is very hard, the excavations being made in a frozen mass of snow, "as hard as sugar," M. Yurgens says. While the work was at a lull, news was received of another mammoth's body discovered only six years ago on the Moloda River, left bank tributary of the Lena, joining it thirty-five miles above Siktyakh, which has remained still untouched. If the news is confirmed, M. Yurgens will make an excursion to discover it.

IN a subsequent letter, dated April 16, M. Yurgens writes that M. Eigner has made magnetic measurements to the east of the station as far as Ust-Yansk. Full measurements were made at ten places, notwithstanding frosts of $-30°$ to $-40°$ C. Mr. Yurgens will make the same measurements to the west of the station. Preparations are already made for the return journey. Several magnetic instruments had to be packed at the end of April and sent on sledges to Bulun. M. Eigner proposed to leave the station at the same time, while MM. Bunge and Yurgens intended to stay at Sagastyr until June 15.

THE following papers were entered to be read, *Science* states, at the Newport meeting of the National Academy of Sciences, Oct. 14 to 16:—On the columella auris of the Pelycosauria, E. D. Cope; the brain of Asellus and the eyeless form of Cecidotæa, A. S. Packard; on the theory of atomic volumes, Wolcott Gibbs; on the complex inorganic acids, Wolcott Gibbs; notice of Muybridge's experiments on the motions of animals by instantaneous photography, Fairman Rogers; notice of Grant's difference-engine, Fairman Rogers; on the thinolite of Lake Lahontan, E. S. Dana; on the Mesozoic coals of the North-West, R. Pumpelly; on the work of the Northern Trans-Continental Survey, R. Pumpelly; the grasses mechanically injurious to live-stock, William H. Brewe; on gravitation survey, C. S. Peirce; on minimum differences of sensibility, C. S. Peirce and J. Jastrow; researches on Ptolemy's star-catalogue, C. H. F. Peters; on the operations of the U.S. Geological Survey, J. W. Powell; the motion of Hyperion, Asaph Hall; remarks on the civilisation of the native peoples of America, E. B. Tylor; some results of the exploration of the deep sea beneath the Gulf Stream by the U.S. Fish Commission steamer *Albatross* during the past summer, A. E. Verrill; recent progress in explosives, H. L. Abbot; on an experimental composite photograph of the members of the Academy, R. Pumpelly; report on meridian work at Carlsruhe, W. Valentiner; on the algebra of logic, C. S. Peirce.

THE meeting of the Cambridge Philosophical Society next Monday at 3 p.m. will be marked by the number and importance of the biological papers communicated. One will be by a lady, Miss F. Eves, Lecturer at Newnham College, on some experiments on the liver ferment. Mr. W. F. R. Weldon will contribute a paper on the supra-renal bodies, on which he has previously made valuable contributions. The remarkable recent development of the study of vegetable morphology and physiology under Dr. Vines will be further evidenced by Mr. Walter Gardiner's paper on the supposed presence of protoplasm in the intercellular spaces, and Mr. J. R. Green's, on a proteid occurring in plants. Prof. Michael Foster is the new President of the Society; Mr. Trotter, Mr. Glazebrook, and Dr. Vines are the Secretaries; and Prof. Cayley, Prof. Macalister, and Mr. Glaisher are the new Members of Council.

THE Statistical Society has issued in one handsome quarto a Catalogue of their most useful collection of books. The Catalogue has been compiled with great care, and on a simple and intelligible plan. The library is deemed to be a class library, and no classification therefore is attempted, the books being arranged in alphabetical order, with reference to size, under their authors' names or otherwise, as described in the preface. Secondly, their are no "*blind entries*," *i.e.* each entry, including cross-references, gives sufficient particulars, including size, to enable any person to recognise the book he is looking for, if there, and at the same time indicate to the attendant, without further reference to the Catalogue, where the book is to be found. Such features are a great comfort to the student.

MICHIGAN, like most other States, is going in for economic entomology. We have received a pamphlet of 31 pages on Injurious Insects, emanating from the Entomological Laboratory of the Michigan Agricultural College, in which Prof. A. J. Cook and Mr. Clarence M. Weed are the principal writers. Several of the usual American pests are noticed, and some are figured. We are sorry to say the figures are original, for although the practice of borrowing *clichés* has extended in the States to a degree that is almost nauseating, the results are usually satisfactory, and had the practice been followed in this instance it would have been to the advantage of this Michigan College. Probably for the first time in America the ubiquitous "Painted Lady" (*Vanessa cardui*) is stigmatised as "injurious"; it is accused of devouring hollyhock, centaurea, and borage. The same insect in Europe, a few years ago, was driven to extremes in order to find anything that would agree with it, and nearly caused a panic with the worshippers of "absinthe," by destroying the wormwood crop in the Canton of Neufchâtel (Switzerland). There are some very useful and suggestive statistics (by Mr. Weed) on the food relations of birds, frogs, and toads (the paper being a "Thesis for the degree of Master of Science"). The first part deals with the food of *young* birds, in which the American robin (a thrush, and not to be confounded with *our* redbreast) figures largely, as do also the "blue bird" and others. Lepidopterous larvæ are the main food, but apologies have to be made (especially in the case of the blue-bird) for the number of spiders destroyed. In the case of young "robins" the molluscous element is small; probably it would be equally small in this country with regard to *young* thrushes or blackbirds, their beaks not being sufficiently strong to enable them to do the shell-breaking. The statistics with regard to frogs and toads do not appear to be of importance one way or the other. Frogs and toads destroy insects (or "Arthropods" in the broad sense), but we fancy the particular food depends upon the conditions under which the individual Batrachian finds itself.

WE have much pleasure in calling attention to the issue, from the Breslau house of Eduard Trewendt, of four new numbers of that comprehensive work, the "Encyclopædia of Natural Sciences"—the 38th number of the first, and the 23rd to the 25th numbers of the second division. The 38th number of the first division brings the "Dictionary of Zoology, Anthropology, and Ethnology" as far as Gewöhnung (Habitua-

tion), and we need only refer in particular to the history of arthropology, of our knowledge of the Mollusca, Reptilia, and Amphibia, the writers of which occupy the front rank in their respective departments. The map of the "Zoological Regions," appended to Reichenow's interesting article on the "Geographical Distribution of Animals," will be much appreciated. The new numbers of the second division contain a continuation of Ladenburg's "Alphabetical Manual of Chemistry," with which might close two goodly volumes of this work. As physical chemistry has found an excellent representative in Prof. Eilhard Wiedemann, so is also industrial chemistry set forth by men of the first ability, whose contributions here will be prized by a wide circle: "Chlorine," by Prof. Heumann (with numerous woodcuts), "Chinoline," by Dr. L. Berend-Kiel, and "Cyanic Compounds," by Prof. Jacobsen. Nor must we omit mentioning the "History of Chemistry" (in No. 23), written for the "Alphabetical Manual of Chemistry" by Prof. G. Hoffmann of Kiel. The "Alphabetical Manual of Mineralogy, Geology, and Palæontology," continued with No. 24 of the second division, has now advanced to the end of the article "Krystallgestalten und Krystallographie" (Crystal Formations and Crystallography), which, along with the preceding article on "Crystals," by Prof. Kenngott, furnishes a very handsome contribution to the work in question, both articles being, moreover, very copiously illustrated. Finally, we have to announce that there will next appear a new botanical number which, among other things, will contain the beginning of a treatise on "Schleimpilze," by Dr. W. Zopf.

Some 154 prehistoric tombs near Santa Lucia by Tolmein, (Gorizia), have been lately examined by Dr. Marchesetti, the director of the Trieste Museum. Their contents were conveyed to Trieste; the excavations will be continued at the instance of the Adriatic Natural History Society, for a period of about two years. During last year Dr. Marchesetti examined another burial-ground, viz. that of Vermo, near Mitterburg (Istria), which belongs to quite another period.

Mr. T. Mellard Reade, C.E., F.G.S., in his presidential address to the Liverpool Geological Society this session, "On the Denudation of the Two Americas," showed that 150,000,000 tons of matter in solution are annually poured into the Gulf of Mexico by the River Mississippi; this, it was estimated, would reduce the time for the denudation of one foot of land over the whole basin—which time has hitherto been calculated solely from the matter in suspension—from 1 foot in 6000 years to 1 foot in 4500 years. Similar calculations were applied to the La Plata, the Amazons, and the St. Lawrence, Mr. Reade arriving at the result that an average of 100 tons per square mile per annum are removed from the whole American continent. This agrees with results he previously arrived at for Europe, from which it was inferred that the whole of the land draining into the Atlantic Ocean from America, Africa, Europe, and Asia contributes matter in solution which if reduced to rock at 2 tons to the cubic yard would equal 1 cubic mile every six years.

For several years the Director of Telegraphs at Haugesund (Norway), Herr A. Reitan, has been making experiments for the purpose of solving the problem whether fish seek places in the sea which are artificially illuminated. In order, however, to make experiments on a larger scale than hitherto, and if possible to demonstrate the value of such illuminations at great fisheries, he has received some specially-constructed electric lamps from Brussels, with which he will continue his experiments during the autumn.

The Natural History Society of Rhineland and Westphalia held their autumn meeting at Bonn. Among the papers read we note those on the forest vegetation of the extreme north-western portion of the Himalayas, by Dr. Brandis, and on the present state of the Phylloxera question in the Rhenish vineyards, by Prof. Bortkau.

At Schrems (Lower Austria) a violent shock of earthquake was felt on the night of October 8–9 at ten minutes past midnight. It was preceded by a subterranean rolling noise, lasting several minutes. The phenomenon was also observed at Zwettl and at Gmünd.

The glaciers in the Dachstein Mountains have again diminished considerably at their lower extremities. Prof. Simony has recently taken a large number of photographs of the summit of the Hohe Dachstein, of the Gosau Glacier, and the Karls ice-field, in order to execute future measurements. The surface of the lowest layers of the Karls ice-field has sunk between 2·5 and 3·2 metres since last year, and the lower end of the Gosau Glacier has receded more than twice that amount. Since about 1849 this glacier has receded more than 600 metres.

We have repeatedly referred to Hayek's "Grosser Handatlas der Naturgeschichte" (published by Moritz Perles, Vienna), which has now reached its completion.

The death is announced of Prof. Eugenio Balbi, Professor of Geography at Pavia University, a son of the celebrated geographer, Adriano Balbi. Born at Florence on February 6, 1812, he died at Pavia on October 18 last.

The Natural History Museum, established by the Committee of the International African Society at Brussels, grows in extent daily. The most recent additions are the skeletons of a chimpanzee, a gorilla, a crocodile, and a sea-cow. The Director of the Karema Station on Lake Tanganyika has forwarded a large collection of birds.

"A Norwegian" writes to point out two errors in Mr. Mattieu Williams's note on the northernmost promontory in Norway. "To call the Knivskjærodde a 'low glaciated tongue of rock' is hardly correct. The ridge is a couple of hundred feet high at least. I have before me a photograph of the cape, taken last summer by Dr. Sophus Tromholt, and which will shortly be placed before the public. The elevation is very considerable. Mr. Williams further states that there are magnificent capes abounding around the North Cape; others are above 1000 feet. This is incorrect. The highest mountain on the *coast* of Arctic Norway is the North Cape, viz. 974 feet. A belief has for many years prevailed in Norway that Knivskjærodden jutted further into the ocean than the North Cape, but it has only been *proved* this summer."

The additions to the Zoological Society's Gardens during the past week include two Rhesus Monkeys (*Macacus rhesus*) from India, presented respectively by Mr. Richard Armytage and Mrs. E. A. Russell; a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, presented by Miss N. Simonds; a Northern Mocking Bird (*Mimus polyglottus*) from North America, presented by Mr. Thomas G. Venables; a Grand Eclectus (*Eclectus roratus*) from Moluccas, presented by Miss Lawson; two Herring Gulls (*Larus argentatus*), British, presented by Mrs. Pigou; an Undulated Grass Parrakeet (*Melopsittacus undulatus*) from Australia, presented by Mr. F. Hale, F.Z.S.; a Water Rail (*Rallus aquaticus*), a Moorhen (*Gallinula chloropus*) from Norfolk, presented by Mr. T. E. Gunn; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Mr. W. G. Brinkley; an Alligator (*Alligator mississippiensis*) from the Mississippi, presented by Mr. R. M. Middleton; a Greater White-crested Cockatoo (*Cacatua cristata*) from the Moluccas, deposited; a Black-headed Caique (*Caica melanocephala*) from Demerara, purchased; a Cape Ant Bear (*Orycteropus capensis*) from South Africa, received on approval.

OUR ASTRONOMICAL COLUMN

BARNARD'S COMET.—The following ephemeris of this comet for Greenwich midnight is deduced from the elliptical elements of Dr. Berberich, of Strasburg, which assign a revolution of $5\frac{1}{2}$ years :—

1884	R.A. h. m. s.	N.P.D. ° ′	Log. distance from Earth	Sun
Nov. 6	22 5 32	101 27·8	0·0041	0·1985
8	— 10 28	100 50·3	0·0147	
10	— 15 20	100 13·3	0·0253	0·2054
12	— 20 8	99 36·8	0·0358	
14	— 24 51	99 0·7	0·0463	0·2122
16	— 29 30	98 25·2	0·0567	
18	— 34 6	97 50·1	0·0670	0·2191
20	— 38 38	97 15·5	0·0772	
22	22 43 7	96 41·4	0·0874	0·2259

The theoretical intensity of light on November 6 is 0·39, and on November 22, 0·24. As previously remarked, it is very desirable that observations of this comet for position should be continued as long as practicable, that its mean motion may be determined with sufficient precision to enable a trustworthy estimate of past planetary perturbations to be obtained. The general resemblance of the elements to those of the short-period comet of De Vico in 1844 will render such an investigation one of much interest.

THE NOVEMBER METEORS.—The earth arrives at the descending node of the first comet of 1866 on the afternoon of Thursday, November 13, and a watch may be favourably instituted on the night of that day for meteors of the stream which appears to lie in the comet's track. Oppölzer's definitive elements give for the radiant point, R.A. 150°·2, N.P.D. 67°·2 (equinox of 1866).

THE LICK OBSERVATORY, CALIFORNIA.—The following is an extract of a letter from Prof. Edward S. Holden, Director of the Washburn Observatory, University of Wisconsin, dated October 17 :—"I have just returned from the Lick Observatory, where I have mounted a beautiful meridian-circle by Repsold of 6 (French) inches aperture. It has north and south collimators of the same aperture, and its axis is a telescope of 2·5 inches aperture, which is viewed by an east (or west) collimator for controlling the azimuth, &c. There are two circles, each divided to 2′, one fixed, the other movable by a wheel and pinion, so that it is not *essential* to determine the division errors of any lines except those for each 1°, and those 2′ lines belonging to 4 degrees, 90° apart. The room is double throughout, a wooden building 40 × 40 feet inside of a structure in louvre-work, which gives a continuous air space all around ; and this air space is connected with a tall ventilating tower which enables the free circulation of air to be maintained. It appears to me to be in all respects satisfactory. The Lick Observatory now needs only its 36-inch refractor to be complete, and they hope for this within three years."

It will be remembered that this Observatory is situate on the top of Mount Hamilton.

VARIABLE STAR IN THE ORION-NEBULA.—The late Prof. Schmidt found that the star which he distinguishes as J″ (Bond 822 = Liapunov γ), which follows θ Orionis 34·3s., and 5′ 5″ to the south of it, disappeared at minimum in his 5-feet refractor, and at maximum reached 9·5m. On April 3, 1878, it was estimated 12·8, equal to Bond 784, but before the end of the month it rose to 9·7. The star may deserve frequent observation.

GEOGRAPHICAL NOTES

THE Rev. Francis A. Allen has issued a reprint of the paper read by him at the late Congress of Americanists in Copenhagen on Polynesian antiquities. The stupendous Cyclopean monuments, platforms, terraces, walls, colossal statues, scattered over the South Sea Islands are graphically described, and regarded as forming a connecting link between the ancient civilisations of Asia and America. The theory is that America was mainly peopled by two streams of migration from Asia—a nomad Mongolic, proceeding directly by the Straits of Behring, and now represented by the Apaches, Utes, Comanches, and other wild tribes of California, Oregon, Colorado, &c. ; and a semi-civilised, proceeding from Further India and China across the islands of the Pacific Ocean to Mexico, Central America, and Peru. On their way across the archipelagoes these peoples left traces of their presence in Micronesia, Hawaii, Tahiti, and especially Easter Island, the last-named distant only some 2600 miles from the mainland of South America. The resemblances between these monuments and those of Peru and Mexico are dwelt upon, and they are further compared with those of Java (Boro-Boro), Cambodia (Angkor-Vaht), and others in Southern Asia. The theory, which is not altogether novel, is supported by other arguments based on considerations of traditions, usages, religions, languages, and the like, brought together from various sources not always of a trustworthy character. It is suggested that the Chinese tradition of the discovery of Fusang by the monk Hoén-Shin may not be altogether an idle tale. Allusion is made to Schoolcraft's exploded legend of Hiawatha ; and some more than doubtful authorities are referred to in proof of the affinities between the American languages and those of Japan, North-East Siberia, and Indo-China. Nevertheless, if not always critical, the paper is learned and lucid, and worth reprinting, if only for the great number of data here brought together as bearing directly or indirectly on the point at issue.

HERR VON HAARDT contributes an instructive memoir to the last number of the *Proceedings* of the Vienna Geographical Society on the services rendered to the progress of the geographical sciences by the Austrian navy. A brief historical survey is given of the famous *Novara* Expedition round the world (1857-59) ; of the survey of the Adriatic coastlands by Capt. T. Ritter (1871) ; the simultaneous determination of the magnetic relations in the same waters by Lieut. J. Schellander ; the expedition of the *Friedrich* and *Donau* to the East Asiatic seaboard (1868) ; the second voyage of the *Donau* to Asia and South America (1874-76) ; the circumnavigation of Borneo by Capt. T. F. von Oesterreicher ; the circumnavigation of Africa by the *Helgoland* and *Friedrich* (1874-75) ; the voyages of the *Pola* to Jan Mayen and the Arctic Ocean (1882-83) ; Weyprecht's discovery of Franz-Josef Land, &c. The memoir concludes with a brief reference to the expeditions now in progress or promised in the near future, such as that of the *Saida* to Australasia (1884-86) ; of the *Aurora* to South America (1884-85) ; of the *Helgoland* to the West African seaboard, and of the *Frundsberg* to the Indian Ocean.

THE same periodical contains the first part of what promises to be a very valuable contribution to the physiography of Caucasia. Much useful information is here brought together from the latest sources regarding the orography, river systems, administrative divisions, and statistics of that region. The present area of the northern section (Cis-Caucasia) is given at 4037 German geographical square miles, of the southern (Trans-Caucasia), 4400 ; total, 8437, or 2740 more than that of the British Isles.

TO this journal F. Blumentritt also sends an account of the little-known Negrito tribes of the district of Principe in the Island of Luzon, Philippine Archipelago. These aborigines, collectively known as Atas (Aetas), and showing distinct physical resemblances to the non-Malay wild tribes of Malacca, are being gradually evangelised by the Spanish missionaries stationed at Baler. Hemmed in between the semi-civilised Tagalas and the fierce Ilongotes, both of mixed Malay stock and speech, they have already been largely affected by Malay influences. But although their language contains numerous Tagala words, expressions, and even grammatical forms, its fundamentally distinct character has been clearly determined. For the purpose of comparison useful vocabularies of about 150 words are appended in five languages: Spanish, Tagala, Negrito of Mariveles (Bataan), Negrito of Zambales, and Negrito of Baler (Principe).

AT the opening meeting of the Royal Geographical Society on Monday, Mr. Joseph Thomson gave an eloquent and highly interesting account of his recent explorations in the country of the Masai. Both the country and the people are of the greatest interest to science, and, as was shown last week, Mr. Thomson's botanical collections are decidedly novel. One or two zoological novelties he has also obtained, and we shall be glad to have the detailed account of his discoveries, which will appear in his forthcoming work.

IT appears from the *Anglo-New Zealander and Australian Times* that Mr. H. O. Forbes, F.R.G.S., is organising a scientific expedition with the view of exploring the botany and zoology of the Mount Owen Stanley Mountains, the great cen-

tral range of the eastern peninsula of New Guinea. Mr. Forbes has been allowed 400*l.* by the British Association and 250*l.* by the Royal Geographical Society towards the expense of the expedition. The party will start early in December, though it is not expected to get into active working before May next, in consequence of the necessity for procuring trusty carriers from the Moluccas. Mr. Forbes will break his journey at Batavia, in order to proceed to Amboyna, where he hopes to find his men. He will then return to Batavia, and sail for Thursday Island, proceeding thence to Port Moresby. He proposes to ascend the course of one of the rivers which flow from the mountains to Redscar Bay. Should the natives prove friendly and the food-supplies sufficient, Mr Forbes does not despair of reaching the other coast of the peninsula; but in any case the exploration of the Mount Owen Stanley Range would be of itself a satisfactory achievement. The mountain travelling is declared to be dangerous to any but very experienced travellers.

NEWS has reached St. Petersburg from Col. Prjevalsky, the indefatigable explorer in Thibet, whose expedition appears to be distinguishing itself in feats of arms as well as discoveries of science. A telegram *viâ* Kiatcha, dated August 20, says:—"The difficult task of the expedition has been successfully accomplished. During the three summer months we traversed 1000 versts of North-Eastern Thibet. We first descended from Zaidam, 400 versts south, over the sources of the Yellow River to the Blue River, which it was found impossible to cross, and then we explored the large lakes in the upper course of the Yellow River. One lake was named 'Russian,' another 'Expedition' Lake. Their height was 13,500 feet, the surrounding country being a mountain plateau 1000 feet higher. Along the Blue River lies a mountainous, but woodless and Alpine country. The climate of the localities passed through was terrible. The whole of the summer was cold, with rain and snow; at the end of May there was sharp frost, in July we had snowstorms like those of winter, while the amount of alluvium deposited by south-western monsoons from the Indian Ocean is so great that in summer Northern Thibet is converted into an almost continuous marsh. Wild animals and fish are abundant, the birds and flora poor, but original. The Tanguts live on the Blue River, and near the lakes of the Yellow River. Here we were twice attacked by about 300 mounted marauders, and the heroic conduct of my companions, armed with Berdan rifles, saved the expedition. We soon repulsed the first attack on July 25, and subsequently destroyed the Tangut camp. A week later a fresh party from another Tangut tribe attacked us. For two hours on the banks of the Yellow River we repelled the mounted brigands with repeated volleys from our rifles; and when we took the offensive the Tanguts retreated behind the knolls, and in turn began volley-firing. We were most fortunate, all coming off safe and sound, only two of our horses being wounded, while forty of the brigands were killed and wounded in the two encounters. We now go to Western Zaidam. We shall establish a depot at Hast, and during the winter explore the surrounding localities."

DR. GERHARD ROHLFS leaves for the West Coast of Africa by one of the German war-ships under Admiral Knorr, and has been intrusted with a special mission by the German Government.

CAPT. BECKER and some other Belgian officers are about to proceed to Zanzibar, thence to start for Lake Tanganyika. They intend to cross this lake, and to found a station on its western shore. Thus the line of stations across Africa, which the International African Society has planned, will be completed. On the eastern side of Lake Tanganyika, between this and the sea-coast, there are four stations: Kondoa, in Usagara; Tabora, in Unyanyembe; Kakoma, in Uganda; and Karema, on the shore of the lake. On the western side there are over fifty stations between the lake and the Atlantic.

THE subject of trade-routes into South-Western China is now engaging attention in France, and has caused much discussion in the periodical press. The various methods of reaching Szechuan and Yunnan which have from time to time been suggested by explorers are dismissed in their turn as impracticable. From the side of India we have the Brahmaputra, which is navigable almost to the Chinese frontier, and the Irrawaddy *viâ* Bahmo. These are described as useless on account of the obstacles offered by lofty and almost impassable ranges of mountains; the Meinam from Bankok would only land us in the Shan States; the Meikong, through Cambodia, was tried by Lagrée, but was found quite unfit for navigation on account of its numerous rapids and cataracts. In China we have the Sikiang—which offers an almost straight line from Canton into Southern China, and was followed by Mr. Colquhoun in his recent attempt to cross through the Shan States into British Burmah—and the Yang-tsze-kiang, but both of these routes, according to French writers, are closed to trade by Chinese hostility. Thus every possible route has been tried and found wanting, with one exception, viz. that by the Songkoi or Red River of Tonquin. By means of this new possession of France the trade of the two great provinces of South-Western China, say the French writers, can be tapped, and in no other way. Their wealth, it is said, will be poured down the valley of the Red River into the hands of the French traders at Hanoi and Haiphong. With regard to routes mentioned only to be dismissed as impossible, nothing need be said here. Their merits and defects may be found described in a score of English works by explorers on the spot; but so far as the Red River is concerned, no proposition either way can be laid down with safety. Beyond Hanoi it is but little known, and its upper waters above Honghoa are almost wholly unknown to Europeans. But one Frenchman has ever ascended or descended the river, and when M. Dupuis made his courageous journeys more than ten years ago, he did so under circumstances which rendered geographical observation impossible. All that M. Dupuis can say (and European knowledge is confined to his information) is that with an escort, and with Chinese passports, he was able to come down the river in a small junk, and to ascend it again with several junks laden with arms and ammunition. Even at the present moment the whole river from Honghoa to Laokai on the Chinese frontier is in the hands of the Black Flags. Moreover it has been stated that after leaving the Red River the route would have to cross a lofty mountain range, and pass through the most desolate region in Yunnan. The river may offer an excellent trade route; but in the present state of our geographical knowledge of Upper Tonquin all that can be said with certainty is that nobody knows whether it is so or not. Happily the French lose no time in thoroughly studying the countries which they occupy, and as soon as a state of peace has been reached in Indo-China we shall be in a position to decide the question; until then anything written about the navigation of the Red River above Honghoa is mere speculation, and valueless for practical purposes.

THE last number of the *Izvestia* of the Russian Geographical Society contains three interesting papers by M. D. Ivanoff on the Pamir, embodying the results of the last year's expedition, and giving a lively summary of our present knowledge as to this very interesting region. A. E. Regel contributes to the same number a note on his journey to the Shugnan; A. Wysheslavtseff describes the burial customs of the Tchuvashes; and P. A. Putyatin contributes a note on the pottery of the Stone Age. The same issue contains, moreover, accounts of the geodetical and cartographical work done in 1883 by the military topographers and by the Hydrographical Department, and several notes.

NATURAL SCIENCE IN SCHOOLS[1]

HOWEVER fully it may be admitted by the few that it is important, nay essential, that all members of the community, whatever their station or occupation, should during their school career receive some instruction in the elements of natural science, the general public have not as yet had brought home to them with sufficient clearness that, just as a knowledge of foreign languages is essential to all who are brought into intercourse with foreigners, so in like manner is a correct knowledge of the elements of natural science of direct practical value to all in their daily intercourse with Nature, apart from the pleasure which such knowledge affords. In fact, judged from a purely utilitarian standpoint, the advantages to be derived from even the most elementary acquaintance with what may be termed the science of daily life are so manifold that, if once understood by the public, the claims of science to a place in the ordinary school course must meet with universal recognition. To quote Huxley[2]:

[1] "On the Teaching of Natural Science as a Part of the Ordinary School Course, and on the Method of Teaching Chemistry in the Introductory Course in Science Classes, Schools and Colleges." Paper read at the Educational Conference of the International Health Exhibition by Henry E. Armstrong, Ph.D., F.R.S., Sec.C.S., Professor of Chemistry in the Finsbury Technical College.

[2] This writer's "Introductory" to Macmillan's Science Primers, and his "Physiography: an Introduction to the Study of Nature," should be studied by all who wish to know what science is and how it should be taught.

"Knowledge of Nature is the guide of practical conduct; . . . any one who tries to live upon the face of this earth without attention to the laws of Nature will live there for but a very short time, most of which will be passed in exceeding discomfort: a peculiarity of natural laws, as distinguished from those of human enactment, being that they take effect without summons or prosecution. In fact, nobody could live for half a day unless he attended to some of the laws of Nature; and thousands of us are dying daily, or living miserably, because men have not yet been sufficiently zealous to learn the code of Nature."

But it is also and mainly on other and far higher grounds that we should advocate universal practical teaching of the elements of natural, and more particularly of so-called physical, science: viz. that it tends to develop a side of the human intellect which. I believe I am justified in saying, is left uncultivated even after the most careful mathematical and literary training: the faculty of observing and of reasoning from observation and experiment. It is entirely from this latter point of view that I shall venture to propound a scheme for teaching the elements of that branch of physical science with which I am most intimately acquainted.

This Exhibition affords some few noteworthy illustrations of the way in which the importance of teaching the elements of natural science has received practical recognition in our schools. Thus we have indications of the work being done by the Birmingham School Board; the London School Board call attention to their system of training pupil-teachers in science; Mr. Robins shows plans of one of the best, if not the best equipped school chemical laboratory—that of the Manchester Grammar School. Also, it is well known that at many of the larger schools, such as Clifton College, Eton, Harrow, Rugby, St. Paul's, Giggleswick, and the North London Collegiate School for Girls, ample provision is made for teaching one or more branches of natural science; and not a few other examples might be quoted. But in how large a proportion of the schools throughout the country is such training neglected? and there is much cause for complaint in the fact that, in those schools in which science is taught, it is after all in most cases but a kind of "refuge for the destitute," only those who have failed on the classical side and those judged to be inferior in intellect being turned over to the so-called modern side. This is probably due to a variety of causes: to the ignorance already referred to of the public of the importance and value of such training, or it would be demanded of the schools; to the ignorance of even the barest elements of science of the majority of teachers in charge of schools; to the want of good science teachers and of suitable books; to the supposed expense of teaching science; and lastly—and I believe this to be the most important of all the causes which operate against the teaching of science—to the imperfection of our method of teaching: there can be little doubt, in fact, that the majority of teachers of the generally recognised subjects who have themselves no scientific knowledge see clearly enough that very little good comes of teaching science in the manner in which it is commonly taught in schools.

The great objection to the method at present in vogue appears to me to be that it is practically the same whether science is taught as a part of the general school course, or whether it is taught professionally; in other words, a lad studies chemistry, for example, at school in just the same way as at a science college, the only difference being that he does not carry his studies so far at school as at college. This, I believe, is the primary fault in our present system. In my opinion, no single branch of natural science should be selected to be taught as part of the ordinary school course, but the instruction should comprise the elements of what I have already spoken of as the science of daily life, and should include astronomy, botany, chemistry, geology, mechanics, physics, physiology and zoology—the *olla podrida* comprehended by Huxley under physiography, but which is perhaps more happily expressed in the German word *Naturkunde*—in so far as is essential to the understanding of the ordinary operations and objects of Nature, the teaching from beginning to end being of as practical a character as possible, and of such a kind as to cultivate the intelligence and develop the faculties of observing, comparing and reasoning from observation; and the more technical the course the better. The order in which these subjects should be introduced is matter for discussion; personally, I should prefer to begin with botany, and to introduce as soon as possible the various branches of science in no particular order but that best suited to the understanding of the various objects or phenomena to which the teaching for the time being had reference. The extent to which instruction of this kind is given must entirely depend on the class of scholars.

There are few teachers capable of giving such instruction, and fewer books of a character suited to ordinary requirements. The development of such a system will, in fact, require the earnest co-operation of a number of specialists; but apart from the difficulty of securing efficient co-operation, there is no reason why some such scheme should not be elaborated at no distant date. If action is to be taken, however, there must be no delay, or the opportunity will be lost. I trust that this meeting will be prepared to give much attention to this question, and that it may be possible to continue the discussion on other platforms, as it is fundamentally important and deserving of the most serious consideration of educationalists. No doubt it will be said that the object of introducing the teaching of science into the school course is to afford mental training of a particular character, not the inculcation of useful knowledge, and that this end can be secured by teaching well some one branch of science. Admitting that this has been the case, however, there is no reason why it should be in the future: if while developing the intellect it be possible—and it certainly is—to impart much valuable information; and if—as it certainly is—the teaching be rendered easier and more attractive because it has direct reference to the familiar objects and operations of Nature. We cannot, indeed, any longer afford to grow up ignorant of all that is going on around us, and without learning to use our eyes and our reasoning powers; we cannot afford to be unacquainted with the fundamental laws of health; but we must ever remember "that knowledge of Nature is the guide of practical conduct," and no effort must be spared to render our system of education an effectual preparation and truly adapted to the exigencies of practical life. The female educators appear already to have grasped the importance of such teaching, and under the guise of domestic economy much that I advocate is being taught in girls' schools; it is to be hoped that ere long something akin to the domestic economy course in girls' schools will find a place in boys' schools.

To pass now to the consideration of the mode of teaching my own special subject in science classes, such as those held under the auspices of the Science and Art Department, and in the introductory course for students in science schools and colleges generally. To deal first with the former. Inspection of the syllabus for the elementary stage, together with the study of the examination papers of the past few years, will show that the student is mainly required to have an elementary knowledge of the methods of preparing, and of the properties of, the commoner *non-metallic* elements and their chief compounds. There is thus practically no distinction to be drawn between the knowledge required of students under the Science and Art Department, and of those who are making the study of chemistry the business of their lives. But surely it is not the function of the Science and Art Department to train up chemists, and I am satisfied that it is neither their desire nor their intention to do so; their object undoubtedly is to encourage the teaching of chemistry as a means of cultivating certain faculties, and in order that the fundamental laws of chemistry may be understood and their commoner applications realised. It is not difficult to understand how the system has grown up and why it is maintained; I not believe it is because the Department consider it a satisfactory one; but they know full well that a better system is not yet developed, and that it would be unwise to legislate far in advance of the intelligence and powers of the majority of the teachers. With all deference, however, I venture to add that the programme has been drawn up too much from the point of view of the specialist, and that too little attention has been devoted to it from the point of view of the educationalist. The course I am inclined to advocate would be of a more directly useful character. There is no reason why in the beginning attention should be confined to the non-metals, especially when certain of the metals enter so largely into daily use; and provided that it involve no sacrifice of the opportunities of developing the faculties which it is our special object to cultivate by the study of chemistry, there is no reason against, but every reason for, selecting subjects of every-day importance rather than such as are altogether outside our ordinary experience, such, for example, as the oxides of nitrogen: even chlorine, except in relation to common salt, might be omitted from special study. The presumed distinction between so-called inorganic and organic chemistry should be altogether put aside and forgotten, and the elements of the chemistry of the carbon compounds introduced at a very early stage in order that the phenomena of animal and plant life might come under consideration. To give the barest possible outline of a programme, I would include such subjects as the following in the syllabus:—

The chemistry of air, of water, and of combustion; the

distinction between elements and compounds; the fundamental laws which regulate the formation of compounds and the chemical action of bodies upon one another (*i.e.* the nature of so-called chemical change); the chemical properties of the metals in ordinary use, with special reference to their uses and the action upon them of air, water, &c.; the composition of natural waters; the distinction between fats, carbohydrates and albuminous substances in so far as is essential to the understanding of the relative values of different foods and respiration and growth in animals and plants (outlines of the chemistry of animal and plant life, in fact); the nature of the processes of fermentation, putrefaction, and decay.

The instruction in these subjects should in all cases be imparted by means of object-lessons and tutorial classes; lectures pure and simple should, as far as possible, be avoided. The students should by themselves go through a number of practical exercises on the various subjects. I would abolish the teaching of tables for the detection of simple salts, the teaching of analysis as at present conducted being, I believe, in most cases of very little if any use except as enabling teachers to earn grants.

In schools and colleges in which chemistry is taught as a science, and ostensibly with the object of training young people to be chemists, it is the almost invariable practice that the student first devotes more or less time to the preparation of the commoner gases, and then proceeds to study qualitative analysis; quantitative determinations are made only during the later period of the course. I believe that the system has two great faults: it is too mechanical, and does not sufficiently develop the faculty of reasoning from observation; and actual practice in measurement is introduced far too late in the course. It is of great importance that the meaning of the terms equivalent, atomic weight, molecular weight, should be thoroughly grasped at an early stage, but according to my experience this is very rarely the case; there is no such difficulty, however, if the beginner is taught to make a few determinations himself of equivalents, &c., as he very well may be. It is not necessary here to enter into a more detailed criticism, but I propose instead to give a brief description of a modification of the existing system which in my hands, in the course of about four years' experience, has furnished most encouraging results, and which I venture to think is worthy of an extended trial.

Instead of merely preparing a variety of gases, the student is required to solve a number of problems experimentally: to determine, for example, the composition of air and of water; and the idea of measurement is introduced from the very beginning, as the determination is made quantitatively as well as qualitatively. Each student receives a paper of instructions—two of which are printed as an appendix to this paper—which are advisedly made as bare as possible so as to lead him to find out for himself, or inquire, how to set to work; and he is particularly directed that, having made an experiment, he is to enter in his notebook an account of what he has done and of the result, and that he is then and there to ask himself what bearing the result has upon the particular problem under consideration, and, having done so, he is to write down his conclusion. He is thus at once led to consider what each experiment teaches: in other words, to reason from observation. Apart from the mental exercise which this system affords, if the writing out of the notes be properly supervised, the literary exercise which it also affords is of no mean value.

In illustration, I may here very briefly describe the manner of working out the second problem in the course. The problem being to determine the composition of water, the student receives the instruction:—1. Pass steam over red-hot iron brads, collect the escaping gas, and apply a light to it. (N.B. The gas thus produced is called hydrogen.) He is provided with a very simple apparatus, consisting of a small glass flask containing water, joined by a narrow bent glass tube to an iron tube (about 9 inches long and $\frac{1}{2}$ to $\frac{3}{4}$ inch wide) in which the brads are placed, a long glass tube suitably bent for the delivery of the gas being attached to the other end of the iron tube. Plaster of Paris is used instead of corks to make the connections with the iron tube. The iron tube is supported over a burner, and heated to redness; the water in the flask is then heated to boiling, and the steam thus generated is passed over the brads; the escaping gas is collected over water in the usual manner. Having made this experiment, and observed that, on passing steam over red-hot iron, the gas hydrogen is produced, the student proceeds to consider the bearing of this observation. The hydrogen must obviously be derived either from the water or from the iron, if not from both. Those who already know that iron is iron, so to speak, at once infer that the hydrogen is derived from the water: it is, however, pointed out that, even if it be known that iron is a simple substance, this observation taken alone does not prove that hydrogen is contained in water.

2. The student next learns to prepare hydrogen by the ordinary method of dissolving zinc in diluted sulphuric acid, and makes a few simple experiments whereby he becomes acquainted with the chief properties of the gas.

3. Having done this, he is instructed "to burn dry hydrogen at a glass jet underneath a cold surface and to collect and examine the product." The product is easily recognised as water, and the immediate answer to the question, "What does this observation teach?" is, that since iron is absent, taken in conjunction with Experiment 1, the production of water on burning hydrogen in air, the composition of which has already been determined, is an absolute demonstration that hydrogen is contained in water.

4. Having previously studied the combustion of copper, iron, and phosphorus in air, and having learnt that when these substances burn they enter into combination with the oxygen in air, the student is also led to infer from the observation that hydrogen burns in air producing water, that most probably it combines with the oxygen, and that water contains oxygen besides hydrogen. It may be however, it is then pointed out, that the hydrogen, unlike the phosphorus, &c., combines with the nitrogen instead of with the oxygen, or perhaps with both. He is therefore instructed to pass oxygen over heated copper, weighing the tube before and after the operation, and subsequently to heat the "oxide of copper" in a current of hydrogen. He then observes that water is formed, the oxygen being removed from the copper: and since nitrogen is absent, it follows that water consists of hydrogen and oxygen, and of these alone.

5. By repeating this last experiment so as to ascertain the loss in weight of the copper oxide tube and the weight of water produced, the data are obtained for calculating the proportions in which hydrogen and oxygen are associated in water.

In practice the only serious difficulty met with has been to induce students to give themselves the trouble to consider what information is gained from a particular observation; to be properly inquisitive, in fact. I cannot think that this arises, as a rule, from mental incapacity. When we consider how the child is always putting questions, and that nothing is more beautifully characteristic of young children than the desire to know the why and wherefore of everything they see, I fear there can be little doubt that it is one of the main results—and it is indeed a lamentable result—of our present school system that the natural spirit of inquiry, inherent to a greater or less extent in every member of the community, should be thus stunted in its growth, instead of being carefully developed and properly directed.

Having in the manner which I have described studied air, water, the gas given off on heating common salt with sulphuric acid, and the ordinary phenomena of combustion, the student next receives a paper with directions for the comparative study of lead and silver (see Appendix). The experiments are chosen so as to afford an insight into the principles of the methods ordinarily employed in qualitative and quantitative analyses, and the student who has conscientiously performed all the exercises is in a position to specialise his studies in whatever direction may be desirable.

The system I have thus advocated undoubtedly involves far more trouble to the teacher than that ordinarily followed, but the student learns far more under it, and I assert with confidence that the training is of a far higher order, and also of a more directly useful character. I believe it to be generally applicable, and that it would be of special advantage in those cases in which only a short time can be devoted to the study of chemistry, as in evening classes and medical schools. At present the only practical teaching vouchsafed to the majority of students in our large medical schools is a short summer course, during which they are taught the use of certain analytical tables: as a mental exercise the training they receive is of doubtful value; the knowledge gained is of little use in after life, and the course certainly ought not to be dignified by being spoken of as a course of Practical Chemistry; *test-tubing* is the proper appellation. It is not a little remarkable also that even the London University Syllabus nowhere specifies that a knowledge even of the elements of quantitative analysis will be required of candidates either at the Preliminary Scientific or First M.B. Examination, and this, too, when, as is well known, an analysis to be of any practical

value must almost invariably be quantitative. It is little less than a disgrace to the medical profession that a subject of such vital importance as chemistry should be so neglected.

If, however, we are to make any change in our method of teaching science, if we are to teach science usefully throughout the country, two things are necessary: teachers of science must take counsel together, and the examining boards must seriously consider their position. There can be little doubt that in too many cases the examinations are suited to professional instead of to educational requirements; and that the professional examinations are often of too general a character, and do not sufficiently take into account special requirements.

APPENDIX

Problem: to Determine the Composition of Air

N.B.—Immediately after performing each experiment indicated in this and subsequent papers, write down a careful description of the manner in which the experiment has been done, of your observations and the result or results obtained, and of the bearing of your observations and the result or results obtained on the problem which you are engaged in solving. Be especially on your guard against drawing conclusions which are not justified by the result of the experiment; but, on the other hand, endeavour to extract as much information as possible from the experiment.

1. Burn a piece of *dry* phosphorus in a confined volume of air, *i.e.* in a stout Florence flask closed by a caoutchouc stopper. Afterwards withdraw the stopper under water, again insert it when water ceases to enter and measure the amount of water sucked in. Afterwards determine the capacity of the flask by filling it with water and measuring this water.

N.B.—The first part of the experiment requires care and must be done under direction.

2. Allow a stick of phosphorus lashed to a piece of stout wire to remain for some hours in contact with a known volume of air confined over water in a graduated cylinder. After noting the volume of the residual gas, introduce a burning taper or wooden splinter into it.

N.B.—The residual gas is called *nitrogen*.

3. Burn a piece of dry phosphorus in a current of air in a tube loosely packed with asbestos. Weigh the tube, &c., before and after the experiment.

4. Repeat Experiment 2 with iron borings moistened with ammonium chloride solution. Preserve the residual gas.

5. Suspend a magnet from one arm of a balance; having dipped it into finely divided iron, place weights in the opposite pan, and when the balance is in equilibrium, set fire to the iron.

6. Pass a current of dry air through a moderately heated tube containing copper. Weigh the tube before and after the experiment; also note the alteration in the appearance of the copper.

7. Strongly heat in a *dry* test tube the red substance obtained by heating mercury in contact with air. At intervals plunge a glowing splinter of wood into the tube. Afterwards note the appearance of the sides of the tube. (Before performing this experiment ask for directions.)

N.B.—The gas obtained in this experiment is named *oxygen*.

8. Heat a mixture of manganese dioxide and potassium chlorate in a dry test tube, and at intervals plunge a glowing splinter into the tube. This experiment is to acquaint you with an easy method of preparing oxygen in quantity.

9. Prepare oxygen as in Experiment 8, and add it to the nitrogen from Experiment 4 in sufficient quantity to make up the bulk to that of the air taken for the latter experiment. Test the mixture with a burning taper or splinter.

10. Dissolve copper in nitric acid and collect the escaping gas (nitric oxide); add some of it to oxygen and some of it to air.

11. Fill a large flask provided with a well-fitting caoutchouc stopper and delivery tube with ordinary tap water and gradually heat the water to the boiling-point; collect the gas which is given off in a small cylinder and add nitric oxide to it. Also collect a sufficient quantity in a narrow graduated cylinder and treat it as in Experiment 2.

Comparative Study of Silver and Lead

Silver.—*Symbol*, Ag. (*Argentum*). *Atomic weight*, 107·67. *Specific heat*, ·05701.

Lead.—*Symbol*, Pb. (*Plumbum*). *Atomic weight*, 206·47. *Specific heat*, ·03140.

1. Determine the relative density of lead and silver at a known temperature by weighing in air and in water.

2. Separately heat known weights of lead and silver for some time in the air, allow to cool, and weigh.

3. Separately convert known weights of lead and silver into nitrates, and weigh the latter. From the data thus obtained calculate the *equivalents* of lead and silver.

4. Convert the known weights of nitrates thus obtained into chlorides, and weigh the latter.

5. Compare the action on lead and silver of chlorhydric acid; of dilute and concentrated sulphuric acid, using the acid both cold and hot; and of cold and hot nitric acid.

6. Using solutions of the nitrates, compare their behaviour with chlorhydric and sulphuric acids, hydrogen sulphide, potassium iodide, and potassium chromate. Ascertain the behaviour of the precipitate formed by chlorhydric acid when boiled with water, and when treated with ammonia solution.

7. Compare the behaviour of lead and silver compounds on charcoal before the blowpipe.

8. Tabulate the results of your experiments with lead and silver in parallel columns.

9. Ascertain whether the substances given you contain lead or silver.

10. Determine silver in an alloy of lead and silver by cupellation.

11. Study the method of determining silver volumetrically by means of a *standard solution* of ammonium thiocyanate. Determine the percentage of silver in English silver coinage.

12. Determine silver as chloride by precipitation.

13. Dissolve a known weight of lead in nitric acid, precipitate it as sulphate, collect and weigh the latter.

14. What are the chief ores of lead and silver? How are lead and silver extracted from their ores? How is silver separated from lead? How is it separated from burnt Spanish pyrites? What are the chief properties and uses of lead and of silver? State the composition of the chief alloys of lead and silver.

TRANSACTIONS OF THE NEW ZEALAND INSTITUTE

VOLUME XVI. of the *Transactions and Proceedings of the New Zealand Institute* contains the more important memoirs laid before its eight incorporated Societies during the year 1883 and the first weeks of 1884. It forms a bulky volume of about 650 pages, and is illustrated by 44 plates. It speaks a great deal for the energy of the able editor, Dr. James Hector, F.R.S., that he has in so short a time reduced such a mass of material into order, and that the volume should be issued in May of this year. While we think the illustrations still leave something to be desired as to their general style and execution, this volume is extremely creditable to the colony, and the amount of accurate research recorded will, if continued, soon make New Zealand one of the most completely investigated regions of the world. Of the 57 articles selected from the papers read before the local Societies, 25 relate to zoology, 22 to botany, 5 to geology, 1 to chemistry, and 4 to miscellaneous subjects. While of the titles of these papers we append a classified list, some few of them merit a more particular reference.

Mr. E. Meyrick contributes a third series of his descriptions of New Zealand Microlepidoptera, treating this time of the Œcophoridæ. This is the principal family of the Tineina in New Zealand, as is also the case in Australia. Some 67 species are recorded, of which 55 are particularly described, but the total number of species it is thought will be much more considerable. In New Zealand the family constitutes about a sixth of the entire Microlepidoptera, in Australia it forms more than a fourth, whilst in Europe it is about a thirtieth. It seems strange that, while this family occupies so prominent a position in both New Zealand and Australia, no species as far as is yet known is common to both. Fourteen genera are found in New Zealand; of these ten are endemic, three occur also in Australia, and one is cosmopolitan. Of the three genera shared with Australia, two (Eulechria and Phlæopola) are large and typically Australian genera, represented in New Zealand by three species, obviously mere stragglers; the third (Trachypepla) is a typical New Zealand genus, probably of considerable extent, and is represented in Australia by two species only, evidently also stray wanderers. Of the ten endemic genera, none are very closely related to Australian forms. It would therefore appear that, while it is not improbable that a slight interchange of species has taken place at some not exceedingly remote period, it seems nearly certain that the group is of

much more ancient origin, and was derived from another and quite distinct region. Incidentally Mr. Meyrick suggests an affinity with South America, but in a collection made by the Rev. T. Blackburn in the Hawaiian Islands, the Œcophoridæ appeared to be altogether absent, their place being taken by a peculiar group of Gelechidæ.

Mr. Meyrick also contributes a monograph of the New Zealand Geometrina. He does this with some diffidence, owing to the difficulties he has laboured under of consulting type specimens and of the absence of works of reference. A large number of published names are reduced to the rank of synonyms; some 30 species are added to the list, which now stands at 89. In addition to the description of both genera and species, analytical tables of these are given throughout, and the monograph appears to be such as will enable the student to easily identify his captures and will still induce him to the further study of this group, and especially to the transformations of the species contained in it.

Capt. F. W. Hutton gives a very important revised list of the land Mollusca of New Zealand. From the ample collections that have passed under his examination, he has been enabled to determine satisfactorily all but a very few of the described species, as well as to indicate fairly their distribution in the islands. The list contains 116 species, of which 13 remain unknown to the author. Seven have been introduced from England. The dentition of 60 and the internal anatomy of 26 species have been described by Capt. Hutton in vols. xiv. and xv. of the *Transactions*. So far as at present known, one-half of the species are confined to the North Island, one-quarter to the South Island, and one-quarter are common to both. The closest connection of the land molluscan fauna would appear to be with North Australia, but there is a considerable generic affinity with the faunas of New Caledonia, Polynesia, and South America.

An interesting paper on the habits of earthworms in New Zealand is contributed by Mr. A. T. Urquhart. The species are not named, but with such wonderful opportunities as Mr. Urquhart possesses for making a collection of these, may we hope that, in addition to his following out his painstaking observations as to their habits, he will also advance science by making a careful collection of the forms and placing them in the hands of some of the able naturalists of the Auckland Institute for description? It will be remembered that Darwin assumes that in old pastures there may be 26,886 worms per acre, and that Henson gives 53,767 worms per acre for garden ground and about half that number in corn-fields. Mr. Urquhart gives, as the result of his investigations of an acre of pasture-land near Auckland, the large number of 348,480 worms as found therein. It being suggested to him that in his selection of the spots for examination he may have unconsciously selected the richest, the experiment was again tried in a field seventeen years in grass. A piece was laid out into squares of 120 feet, and a square foot of soil was taken out at each corner; worms hanging to the side walls of the holes were not counted, and in one hole, where the return of worms was a blank, the walls were crowded with worms. As a result there was an average of 18 worms per square foot, or 784,080 per acre. Although this average is very striking when compared with that of Henson, it is worthy of note that the difference between the actual weight of the worms is not so marked. According to Henson, his average of 53,767 worms would weigh 356 pounds, while Mr. Urquhart finds that the average weight of the number found by him came to 612 pounds 9 ounces.

Apropos of a description of the head in *Palinurus lalandii*, by Prof. T. Jeffery Parker, founded on specimens which happened to be brought on board at the Cape of Good Hope during his voyage to New Zealand, we have a very natural classification of the species of this genus offered to us. The genus Palinurus, Fabr., would contain three subgenera. For the species in which the stridulating organ is absent and the procephalic processes are present Prof. Parker proposes the very appropriate generic name of Jasus; while for those forms in which the stridulating organ is present and the procephalic processes are absent he would reserve the name Palinurus, Fabr., retaining Gray's subgenus Panulirus for the longicorn species. He notes that, omitting *P. longimanus* and *P. frontalis*, of which he could obtain no definite information, all the species of Jasus are confined to the Southern Hemisphere (Ethiopian and Australian Regions); and those of Palinurus are restricted to the Northern Hemisphere; while those of Panulirus occur in both Hemispheres.

Dr. Walter Buller furnishes a series of notes on some rare species of New Zealand birds. *Sceloglaux albifacies*, the laughing owl, has been found by Mr. W. W. Smith in deep fissures of the limestone rocks at Albury, near Timaru. After many futile efforts Mr. Smith bethought himself of smoking them out; after a few whiffs the owls began sniffing, and then in a few moments quietly walked out; four were captured. They soon became quite tame. On waking up at nightfall, their call was "precisely the same as two men cooeying to each other from a distance." The male is the larger and stronger bird, with a harsher cry. The female performs most of the duty of hatching. They showed a decided perference for young rats, but would eat beetles, lizards, mice, or mutton. The crannies of the rocks in which they make their nests and live during the day are dry, very narrow at their entrance, and often five or six yards in depth. While casting their feathers they become almost naked, and two of Mr. Smith's birds while in this state were stung to death by a swarm of bees which passed through the wire netting of their cage.

Mr. R. H. Govett gives some startling facts as to the bird-killing powers of *Pisonia brunoniana* or *P. sinclairii*. A sticky gum is secreted by the carpels when they attain their full size, but is nearly as plentiful in their unripe as in their ripe condition. Possibly attracted by the flies which embalm themselves in these sticky seed-vessels, birds alight on the branches, and on one occasion two Silver-eyes (Zosterops) and an English sparrow were found with their wings so glued that they were unable to flutter. Mr. Govett's sister, thinking to do a merciful act, collected all the fruit-bearing branches that were within reach, and threw them on a dust-heap. Next day about a dozen silver-eyes were found glued to them, four or five of the pods to each bird. She writes:—"Looking at the tree one sees tufts of feathers and legs where the birds have died, and I don't think the birds could possibly get away without help. The black cat just lives under the tree, a good many of the birds falling to her share, but a good many pods get into her fur, and she has to come and get them dragged out." In a note Mr. T. Kirk says that *Pisonia umbellifera*, Seeman, = *P. sinclairii*, Hook. f., is found in several localities north of Whangerei, both on the east and west coasts, also on the Taranga Islands, Arid Island, Little Barrier Island, and on the East Cape, possibly in the last locality planted by the Maoris. The fruiting pericarp is remarkable for its viscidity, which is usually retained for a considerable period after the fruit is fully matured. It can be readily imagined that small birds tempted to feed on the seeds might easily become glued to a cluster of fruits.

Among new species of plants collected on Stewart Island by Mr. Kirk, he describes a beautiful new Olearia (*O. traillii*), called after his old and valued friend C. Traill, who has done so much for the natural history of Stewart Island. It forms a large shrub from five to twelve feet high. The terminal panicles are from four to nine inches long. The disk florets are purple. It is one of the most striking plants in the New Zealand flora, and one we hope we may soon see in cultivation. Mr. Kirk also, among other important contributions, publishes notes on Carmichaelia with descriptions of new species, one of which, *C. uniflora*, seems to be the same as a new species, with the same specific name, described in a paper read the same night before the Wellington Philosophical Society by Mr. J. Buchanan.

Mr. J. Buchanan gives an interesting account of Campbell Island and its flora. The island, thirty miles in circumference, is three good days' steaming from Wellington. Peat abounds, and the soil is extremely damp in the low-lying regions. The highest altitude is 1500 feet. Only a day and two half-days were available for botanical research, but five species were added to the flora, of which three were new. Many of the species had large and showy flowers, such as *Celmisia vernicosa*, Hook. f., and the various species of Pleurophyllum. These and the like were confined within an altitudinal range of 500 feet above sea-level, but the shrubby forms, such as species of Coprosma, Drachophyllum, Veronica, and Myrsine, ranged from sea-level, where they were most abundant, to the highest altitude. An Alpine flora may also be recognised, as a few plants were only found at the highest altitude, such as *Gentiana concinna*, Hook. f., and *Trineuron spathulata*, Hook. f.

Mr. T. F. Cheeseman contributes a very valuable revision of the New Zealand species of Carex, admitting 40 species, of which 25 are peculiar to the country; of the other fifteen found elsewhere, eleven are recorded from Tasmania and Australia, nine of these are found in Europe, North and West Asia, and North America, seven in Southern or Eastern Asia, six

in temperate North and South Africa, and four or five come from extra-tropical South America.

We can only direct general attention to Mr. Justice Gillies' important paper giving the result of his experiments in 1882-83 on the production of sugar from Sorghum, which seem to have been most successful, and to give promise of a good future for sugar-making in the colony; and to Mr. W. Arthur's report on the brown trout introduced into Otago.

Zoology.—E. Meyrick, New Zealand Microlepidoptera and Geometrina; R. W. Fereday, new species of Cidaria; T. H. Potts, on a species of Mantis; W. M. Maskell, on new Coccidæ; Geo. M. Thomson, new Crustacea and Pycnogonida; C. Chilton, New Zealand sessile-eyed Crustacea; T. Jeffery Parker, on Palinurus; A. T. Urquhart, habits of earthworms; Capt. F. W. Hutton, revision of land Mollusca, of recent Rhachiglossate Mollusca, new species of Mollusca; H. B. Kirk, Anatomy of *Sepioteuthis bilineata*; Dr. J. von Haast, occurrence of the Red Phalarope in New Zealand; Dr. W. Buller, notes on rare birds; Prof. T. J. Parker, on the occurrence of some rare fishes; Dr. Hector, notes on New Zealand ichthyology.

Botany.—W. Colenso, further contributions to New Zealand botany; J. D. Enys and T. Kirk, *Botrychium lunaria* in New Zealand; T. Kirk, botanical notes, descriptions of new species of plants; J. Adams, the botany of the Thames goldfields; A. T. Urquhart, the spread of the Eucalyptus; J. Buchanan, notes of new and rare plants, Campbell Island and its flora; Charles Knight, Lichenographia of New Zealand; T. F. Cheeseman, additions to New Zealand flora, revision of the genus Carex (New Zealand species).

Chemistry.—J. A. Pond, the pottery clays of Auckland district.

Geology.—R. M. Laing, thermal springs at Lyttelton; H. Cox, new minerals; Captain F. W. Hutton, the lower gorge of the Waimakariri; D. Sutherland, discoveries near Milford Sound.

Miscellaneous.—W. Arthur, brown trout introduced into Otago; Mr. Justice Gillies, Sorghum experiments, 1882-83; Coleman Phillips, the law of gavelkind, a reply to Messrs. George and Wallace.

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 27.—M. Rolland, President, in the chair.—Remarks on the first volume of the late M. Dumas' "Discours et Éloges Académiques," presented to the Academy by M. J. Bertrand.—Note on contaminated waters in connection with the spread of cholera, by M. Marey. A careful study of this epidemic since its first appearance in Europe, together with some personal observations in Paris and other parts of France, have convinced the author that the disorder is propagated chiefly through the medium of water. All other influences are of secondary importance, so that to secure the purity of drinking-water in every affected locality should be the first care of the sanitary authorities.—On the formation of saltpetre in plants, by MM. Berthelot and André.—On the oxidation of copper, by MM. Debray and Joannis.—On the laws determining the penetration of the rolled plates of ironclads by projectiles, by M. Martin de Brettes.—On the employment of the aqueous solution of the sulphuret of carbon for the destruction of Phylloxera, by M. A. Rommier.—Account of an easy process for rapidly preparing solutions containing sulphuret of carbon in large quantities, by M. Ach. Livache.—Observations of the lunar eclipse of October 4, made at the Observatory of Lyons (Brunner 6-inch equatorial), by M. Gonnessiat.—Observations of the comets of Barnard and of Wolf made at the Observatory of Lyons (Brunner 6-inch equatorial), by M. Gonnessiat.—On a representation of the exponential function by an infinite product, by M. R. Lipschitz.—On the equilibrium of a homogeneous segment of a revolving paraboloid floating on a fluid, by M. Em. Barbier.—Measure of the horizontal component of terrestrial magnetism by the method of amortisement, by M. J. B. Baille.—Note on the relation between temperatures and pressures of the protoxide of liquid carbon, by M. V. Olszewski.—On some reactions of chlorochromic acid, by M. Quantin. The oxide of carbon acting alone on chlorochromic acid changes it to a green sesquioxide of chromium and to a violet sesquichloride. The simultaneous action of the oxide of carbon and of an excess of chlorine changes integrally the oxychloride of chromium to a sesquichloride.—Chemical analysis of the apatite (phosphate of calcium) occurring at Logrozan in Spain, by M. A. Vivier.—On a graphic granite with large crystals of chlorophyllite from the banks of the Vizézy near Montbrison (Loire), by M. F. Gonnard.—Heat of combination of the compounds of hydrogen and oxygen, by M. A. Boillot.—On the phenomena accompanying the solar corona at present visible in the Alps, by M. Duclaux. These phenomena are regarded as purely atmospheric, the sun being merely the luminous source. The solar corona itself is attributed to normal although rare causes, and is considered as analogous to the halo so often observed round the moon, when the atmosphere is charged with moisture.—Observation of the solar coronas during the aërostatic ascents of October 23 and 24, by MM. A. and G. Tissandier.—Note on solar energy and the oscillations of the magnetic needle, by M. Duponchel. From the observations made from the middle of the sixteenth century down to the present time the author infers that the secular variations of the needle are due to the action of a new ultra-Neptunian planet which he names the *Ocean*, and which may have a revolution of about 467 years. This planet must have passed through the longitudes 80° and 260° about the years 1580 and 1813, and should now be in the longitude of 314° in the constellation of Capricorn.—Note on the employment of hydrosulphuric acid for discharging colours, by M. A. Gérardin. This acid, discovered by M. Schützenberger, and now extensively employed, produces remarkable effects, acting by reduction, contrary to chlorine and oxygen, which act by oxidation. This property seems capable of important industrial application.—Note on distilled water used for drinking-purposes, by M. A. Hureau de Villeneuve. The author argues that the price of distilled water might be greatly reduced by obtaining it from steam-engines at work in mills; that it is neither unpalatable nor difficult to digest; that it generally contains a sufficient quantity of air, and that the absence of calcareous salts is rather an advantage than a drawback.

CONTENTS

THURSDAY, NOVEMBER 13, 1884

WORLD-LIFE

World-Life; or, Comparative Geology. By Alex. Winchell, Professor of Geology in the University of Michigan. Pp. 642. (Chicago: Griggs, 1883.)

AT the present day cyclopædic knowledge has become very rare, and a scientific man is generally like a miner intent on his own special shaft, and too often careless or ignorant of the general plan of the whole mine of science. The work of the collator and summariser is thus continually rising in importance, and care, patience, and judgment are now more requisite than ever before. Although these scientific "consolidation acts" can hardly fail to be open to criticism, yet every man of science must receive them with gratitude, for they afford him a general view of his science, and furnish him with a useful repertory of reference.

In this work Prof. Winchell's field is very wide, when he undertakes to collate astronomy, cosmogony, and geology, in the widest acceptation of these terms. So many subjects does this book touch on that it will only be possible within the limits of an article to give a general view of its scope. The author's reading has been extensive, and we are glad to observe that copious references are provided. He expounds with care, although perhaps sometimes too diffusely, the views of many writers, and thus brings to a focus a great mass of literature, and his own speculations are generally interesting, although not always above criticism.

As already indicated, this work is intended to give a general survey of stellar and planetary systems, to note the marks of evolutionary processes revealed by the telescope, to discuss various cosmogonic theories, to examine the probable life-histories of nebulæ, suns, planets, and satellites, and to consider the influences under which the surfaces of planets are modelled and transformed.

Modern cosmogony is properly a department of physics and dynamics; but when states of matter irreproducible in the laboratory, and the mechanics of systems too complex for rigorous mathematical treatment, are dealt with, moderation in the general reasoning employed has not always been duly observed. No one can doubt that speculation is of the highest scientific importance, but it is also equally certain that in work of this kind a descending scale may be formed, beginning with speculations founded on rigorous mechanical principles and ending with wild and lunatic fancies. Every writer on such topics must, I suppose, sometimes question himself with misgiving as to where in such a list his name would stand. Mr. Winchell appears to treat all speculations with judgment, although one is sometimes tempted to think the exposition over-elaborate and the consideration too patient.

The first part or book is entitled "World-Stuff," and begins with a good account of meteors and meteoric dust. The author thinks that, according to Mr. Aitken's theory of the formation of fog, the highest clouds in our atmosphere reveal the presence there of a very fine dust, probably of cosmic origin. The sunset-glows of last winter appeared

to illuminate clouds at an unusual altitude: may not these clouds have owed their existence to the very dust which caused the glow?

The zodiacal light is then described, and is attributed to swarms of meteorites circulating round the sun, and the visibility of the light on both horizons simultaneously is taken as showing that the orbits of some of them are greater than that of the earth. The author also suggests the probability that swarms of meteorites circulate about the planets as satellites.

Comets, whose association with meteorites is now generally accepted, are described. Later (p. 77) the author writes:—

> "The phenomena of the tail, especially in the vicinity of aphelion, are such as would result if we could conceive the nucleus of the comet surrounded by an aura extending on all sides as far as the remotest limits of the tail, and could recognise the tail as merely a *luminous shadow* cast by the nucleus in intercepting certain radiant energy proceeding from the sun. . . . The tail would be, therefore, not a material form moving with the comet, but something perpetually renewed, while the older and more distant emanations disappear from visibility."

That theory which divides the tails of comets into three classes, according to the gas of which they are formed, is not given.[1]

The nebulæ are then passed in review, and are well illustrated by drawings. They are classified as amorphous, spiral, spiro-annular, annular, and planetary, and the class is taken as giving an indication of the stage of evolution.

In the case of a spiral nebula, such as that in Canes Venatici (Fig. 8, *op. cit.*), it seems difficult to believe that we view the whole. And we suggest that the great mass of the gas is non-luminous, the luminosity being an evidence of condensation along lines of low velocity, according to a well-known hydrodynamical law. From this point of view the visible nebula may be regarded as a luminous diagram of its own stream-lines.

In the second chapter the author enters on the generation of heat in nebular masses. The discussion appears unsatisfactory, and as it is a matter of primary importance, I propose to make some criticisms thereon. The usage of mechanical and thermic terms is loose, so that it is somewhat difficult to determine the author's meaning.

The question is concerning the generation of heat in a contracting nebular mass, and on p. 86, § 9, he concludes:—

> "It is true, then, that contraction develops heat, and that its development delays final refrigeration; that is, the progress toward final refrigeration is not as rapid as the amount of radiated heat implies. But it is not true that contraction (from cooling) can have developed the whole amount of heat at any time existing in the mass, or can even maintain a body at a constant temperature."

From this conclusion I venture to dissent, and in order to show my grounds I will give a paraphrase of the author's argument, as far as I am able to grasp it.

Let there be two similar planetary spheres with layers of equal density similarly arranged, and let the linear dimensions of the smaller (or say configuration β) be 1-nth of those of the larger (or say configuration a); or,

[1] This was sketched by Prof. Ball in his late lecture at Montreal, but I have unfortunately forgotten the originator's name

in other words, let a and a/n be any corresponding radii of α and β.

Let the mass, however, contained within radius a of α be equal to that within radius a/n of β; so that β might be formed from α by simple contraction; and suppose both systems to be in hydrostatic equilibrium. Then it is easy to show that if ρ be the density at any point of α, the corresponding density of β is $n^3\rho$; and if p be the pressure at the same point of α, the corresponding pressure of β is n^4p; and lastly, the modulus of elasticity being $\rho dp/d\rho$ at any point of α, the corresponding elasticity of β is $n^4\rho dp/d\rho$.[1]

Now if we suppose the mass to have contracted from a state of infinite dispersion to the configurations α or β, there must in each case be a certain exhaustion of potential energy of mutual attraction of matter, developing heat in the mass. Then it may be shown that if h is the exhaustion of energy of the matter within a radius a in passing from infinite dispersion to configuration α, the exhaustion of energy of the matter within a radius a/n in passing from infinite dispersion to configuration β is nh.[2] The same is also true of any stratum in course of its contraction. If we take a succession of configurations with radii infinity, 1, $\frac{1}{2}$, $\frac{1}{3}$, &c., in harmonic progression, a constant amount of heat will be generated in passing from any one configuration to the next.

Now let us suppose that in course of contraction neither convection, conduction, nor radiation takes place; then if the temperature in the condition of infinite dispersion be zero, and if the specific heat be constant, the temperature of any stratum a of α being θ, that of stratum a/n of β will be $n\theta$. In this case $\rho\theta$, being density multiplied by absolute temperature, becomes, in passing from α to β, $n^4\rho\theta$. If, therefore, the modulus of elasticity varies as density multiplied by temperature, we have the elasticity in β n^4 times that of α. But we have already seen that $\rho dp/d\rho$ is augmented in passage from α to β by the factor n^4. Hence the hypotheses as to arrangement of strata, specific heat, and law of elasticity are such as to insure equilibrium in every configuration, if it holds in any. This law of elasticity is that of the *isothermal* contraction of a so-called perfect gas.

Now Mr. Winchell's argument appears to me to be that, when there is loss of heat by radiation, there is necessarily deficiency of temperature to make up the elasticity, and thus equilibrium is impossible unless we look for heat from other causes. He does not seem to notice, however, that it will be far nearer the truth (if any such physical hypotheses can be said to be near thereto) to take the elasticity from the adiabatic contraction of the perfect gas, which we know to vary as $\rho^\gamma\theta$, where $\gamma = 1{\cdot}408$. With this law the argument breaks down. In any case the constancy of specific heat, the similarity of successive configurations, and the law of elasticity of "perfect" gases are untenable. In order, however, to do justice to the author I must point out that he attributes later the supply of heat to "conglomeration," which differs I presume from "contraction" in the supposed absence of hydrostatic equilibrium in successive stages, and in the irregularity of the masses concerned.

The paragraph in this chapter on nebular rotation appears to clothe the matter in an unnecessary mystery. Surely we may admit that the existence of a nebular mass with an absolute zero of resultant moment of momentum is highly improbable; and if the expanded nebula has finite resultant moment of momentum, then *must* the agglomerated nebula rotate. Even with zero momentum the nebula might perhaps divide into two portions with equal and opposite momenta.

We next come to paragraphs on nebular annulation and the "spheration" of rings. The intractability of these problems to mathematical treatment renders the discussion highly speculative, but the author seems to treat his subject with discretion.

The second main division of the work bears the title of "Planetology." An elaborate survey of the solar system is given, with a consideration of the arguments for and against the nebular hypothesis. The fact that the inner satellite of Mars revolves in a period shorter than that of the rotation of its planet is regarded as a great difficulty in the acceptance of Laplace's theory. Our author, whilst suggesting as an explanation a diminution of the primitive period through the influence of a resisting medium, refers favourably to the theory that solar tidal friction has retarded the planet's rotation whilst leaving the period of the satellite unaltered. I have myself regarded the fact of which we speak as a very striking confirmation of the importance of tidal friction in planetary evolution.

Faye's modification of the nebular hypothesis, in which the planetary annuli are supposed to arise in the interior of the nebula, is criticised by Mr. Winchell with some success. An account is also given of Spiller's theory. That author rejects the annuli entirely, and supposes the planets to arise by a combination of tidal action with centrifugal force. The formation of the planet is supposed to take place after the central mass has reached the condition of igneous fluidity.

"It is manifest that a separated planetary mass must produce a tidal swell of some magnitude upon the fluid central mass. . . . At some perihelion of the planet therefore—concurring perhaps with a conjunction of planets—the centrifugal tendency of the equatorial portion of the central fluid mass would exceed gravitation, and the tidal swell would be lifted bodily from connection with the central mass. . . ."[1]

Neptune generated Uranus, Uranus Saturn, and so on.

Now I venture to say that Spiller could not have made any numerical estimate of the efficiency of a planet's tidal action on the sun, or he could not have proposed this fantastic theory.[2] It would therefore hardly have seemed to me worth while to have referred to this passage had not Mr. Winchell stated that this theory might be regarded as a prototype of one of my own.

I had suggested that when the earth, then without a satellite, was rotating in four or five hours, the free period of oscillation of the fluid planet would be almost the same

[1] The reader acquainted with Laplace's theory of the earth's figure will have no difficulty in proving this, or even a simple acquaintance with hydrostatic principles will suffice.

[2] The exhaustion of a homogeneous sphere of mass M and radius a is $\frac{3}{5}\mu M^2/a$, where μ is the attractional constant. Hence for a heterogeneous sphere we have $\frac{16}{3}\pi^2\mu\int_0^a \rho^2 a^4 da$. If ρ becomes $n^3\rho$ and a becomes a/n, obviously the exhaustion becomes n times as great as before.

[1] P. 213, *op. cit.*

[2] For such an estimate see a paper "On the Tidal Friction of a Planet attended by several Satellites, &c." (*Phil. Trans.* Part 2, 1881). On p. 515 it is shown that, supposing the coefficient of viscosity in the sun to be the same as that in the earth, then the increase of earth's orbital moment of momentum due to earth's tides in the sun is 1/113000th part of that due to sun's tides on the earth. See also Table III. p. 526.

as the period of the solar semi-diurnal tide, and that the solar tide might undergo such kinetic augmentation as to rupture the planet. A piece torn off might form the moon. The suggestion was only thrown out tentatively, and it might perhaps have been better had it been suppressed. The whole essence of the suggestion lies, however, in the approximate identity of the free and forced periods of oscillation, and this reasoning has no place in Spiller's theory.

In considering the history of a cooling planet, the author is opposed to Sir William Thomson, and concludes that the surface would harden into a crust. It seems to me that the time is hardly ripe for a very confident opinion on the point.

A large place is given in this book to the influence of tides in the evolution of a planet. A description is given of the tidal retardation of planetary rotation and the recession of the satellite; and the chapter is in fact principally a *résumé* of my own papers. The author is at one with me in rejecting Prof. Ball's view, that an enormous exaggeration of marine tides can have taken place within geological history. He is inclined to adopt the view that the trends have been imparted to our great continents by means of the wrinkling consequent on tidal friction in a primitively viscous mass; but he hardly notes, as I pointed out, that if this be so we have to accept a continuous adjustment of the general ellipticity of the earth to a figure of equilibrium, without obliteration of the wrinkles. The suggestion is thus perhaps placed in almost too favourable a light.

On p. 282 Mr. Winchell speaks as though solar tidal friction is adequate to cause a sensible lengthening of the year, so that in earlier ages it was sensibly shorter. It is impossible to admit the correctness of this view, as I have elsewhere shown.[1]

In a section on orogenic forces we have, amongst much other interesting matter, an account of M. Favre's experiment, in which a layer of clay is placed on a tense elastic membrane, which is then allowed to contract: an illustration of many of the facts of mountain geology is thus furnished.

In the following chapter the author follows the various lines of argument by which limits are placed on the age of a planet, and by a subsequent geological discussion endeavours to derive a time scale; but I feel incompetent to judge of the worth of the conclusion. We may regret to find the revival in this place of Prof. Haughton's argument, viz. that the absence of a measurable nutation of 306 days proves the enormous antiquity of the elevation of Europe and Asia. The argument is, I think, worthless, as I believe that Prof. Haughton now admits.[2]

The principal topics dealt with in the rest of the book are the geology of the moon, the physical condition and habitability of other planets, and the final effects of tidal friction.

The fourth main division of the book is historical, and contains a review of the evolution of cosmogonic theories, with an exposition of the speculations of Kepler, Descartes, Leibnitz, Swedenborg, Kant, Lambert, William Herschel, and Laplace.

From the account which has now been given of this work it must be evident that Mr. Winchell set before himself a task of portentous magnitude, and that he has performed it conscientiously. The criticisms which have been made should not impair the conviction that the student of this group of subjects will find his work of great value. G. H. Darwin

[1] *Phil. Trans.* Part 2, 1881, p. 524: "From this it follows that, if the whole of the momentum of Jupiter and his satellites were destroyed by solar tidal friction, the mean distance of Jupiter from the sun would only be increased by 1 25000th (*misprinted* 1 2500th) part. The effect of the destruction of the internal momentum of any other system would be very much less."

[2] See *Proc. R S.* February 19, 1878, No. 186, p. 1, "On Prof. Haughton's Estimate of Geological Time."

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Pentacrinoid Stage of Antedon rosaceus

In compliance with Prof. Herdman's request, I have to state that my experience—acquired during seven years of consecutive dredging in Lamlash Bay (1855-61)—is in entire accordance with his own. Although the most active period of reproduction in *Antedon rosaceus* is undoubtedly (as stated by Sir Wyville Thomson) the *early* part of the summer, so that the Pentacrinoids which spring from the ova then matured and fertilised are ready to drop off their stems in the succeeding autumn, yet I never failed to obtain *Pentacrinoids* in all stages, as well as *Antedons* still "in fruit," throughout the months of August and September. In fact, the whole of my study of this type—which, as regards the skeleton, is fully recorded in my memoir in the *Philosophical Transactions* for 1865, and of which, as regards the soft parts, a general account is given in the *Proceedings* of the Royal Society for 1876, was carried out during those months; my official duties keeping me in London until after the first week in August.

I may take this opportunity of directing the attention of those interested in Crinoidal structure (1) to a communication I have recently made to the Royal Society (*Proceedings*, May 29) on the Nervous System of the Crinoids; (2) to a paper by Prof. A. Milnes Marshall in the *Quarterly Journal of Microscopical Science* for July last; and (3) to a paper by Dr. Carl Jickeli of Jena, in the *Zool Anzeiger*, 7 Jahrgang, No. 170.—The doctrine I propounded on this subject nearly twenty years ago (that the quinquelocular organ contained in the centro-dorsal basin of *Antedon* is a *nerve-centre*, and that the radial cords issuing from it, which traverse the calcareous segments of the arms and pinnules, and give off branches to the successive pairs of muscles, are *nerve-trunks*), though supported by the experimental evidence which I published in 1876, and by the careful microscopic investigations of my son, Dr. P. Herbert Carpenter, has not been accepted by Zoologists generally; being for the most part either ignored altogether, or pooh-poohed as "evidently" fallacious, because inconsistent with homological theory. When I made my recent communication (1) to the Royal Society, summing up the very remarkable confirmatory evidence afforded by my son's inquiries, and referring (as Prof. Marshall had kindly enabled me to do) to the then unpublished results of his experiments (2), which entirely tallied with my own, Prof. Huxley, while admitting the strength of my case, remarked that the position I assign to the nervous system of the *Crinoidea* is as anomalous (in relation to that of Echinoderms generally) as it would be for a Vertebrate animal to have its spinal cord lying along its ventral surface. In reply, I asked, "What more proof *can* you ask for, of the nervous function of the quinquelocular organ and radial cords?" The only additional evidence that Prof. Huxley could suggest, was the result of electric stimulation. Before my paper was published in the *Proceedings*, I learnt (3) that this experiment had been actually tried four years ago by Dr. Jickeli, whose results entirely confirmed my doctrine.

It is to be hoped, therefore, that those who have so confidently and persistently clung to a homology, which is in direct contradiction to the most complete and conclusive proof that experiment can afford—supported as this is by the large body o

anatomical and histological evidence summarised in my recent paper—will now see that unless they can disprove the statements of Prof. Marshall, Dr. Jickeli, Dr. P. Herbert Carpenter, and myself, they are bound to admit my doctrine, and to show how their theoretical homology is to be reconciled with it.

WILLIAM B. CARPENTER

56, Regent's Park Road, London, N.W., November 3

Natural Science for Schools

THE thoughtful and suggestive paper of Prof. Armstrong in the last number of NATURE (p. 19) is to be commended to the attention both of science teachers and of the head masters of our schools. It is undoubtedly true that, with few exceptions, science is still either completely neglected by our schools or handled in a way which does not at all tend to advance its interests. When it is made a "refuge for the destitute," or considered only fit for those intellectually unequal to the study of classics and mathematics, no wonder that observant head masters conclude that little good is to be got from it.

As a science master of many years' experience (having been in fact responsible for the introduction of science into *two* of the schools named by Prof. Armstrong as exceptions to the universal indifference), you will perhaps allow me to call attention to the importance of Prof. Armstrong's paper, and to give the conclusions to which my own experience has led me.

The importance of clearly understanding the purpose with which science is to be studied, and the distinction to be borne in mind between the best curriculum for those who are to be professed chemists and those who will not carry the study of chemistry beyond their school-days is obvious; but I wish to point out how entirely science masters are at the mercy of examiners, both of University examiners, periodically examining a school, and of examiners for open scholarships. My own experience is to the point. Fully persuaded of the uselessness of attempting to make an analytical machine out of the ordinary school-boy giving two or three hours a week to chemistry for two or three years, and of the very small amount of education to be obtained from such a course, I endeavoured to model my instruction in practical chemistry much upon the lines adopted by Prof. Armstrong, and exemplified in the appendix to his paper. When the examinations came, it was duly explained to the examiner that the course of instruction adopted had been unusual, but, all the same, the papers set were of the usual kind:—"Analyse the mixture A," "Determine the metals and acids present in the solution B," &c. On such a paper, of course, the boys failed, and a depreciatory report was sent up by the examiners, with the result that the governors of the school thought it their duty to interfere, and request that "more attention should be given to practical chemistry." Consequently my attempt had to be abandoned, and we returned to our "test-tubing."

Scholarship examinations, being presumably of those who will carry the study much further, may more reasonably demand a knowledge of the ordinary methods of analysis, but I am glad to see that a considerable change has taken place in the papers set, and that now the questions proposed are often such as to place the mechanical analyst at a disadvantage, and to encourage the intelligent observation and interpretation of phenomena.

Prof. Armstrong of course writes as a chemist. But there can be no doubt that certain portions of physics are educationally more useful, and it seems to be only the difficulty of arranging practical work in physics which has led to the present state of things, where practical science work in schools means nearly always practical chemistry. But Prof. Armstrong's protest against allowing this to degenerate into "test-tubing" should not be disregarded. There seems also no reason why *elementary* instruction in science—whether chemistry, or botany, or physiography—should not deal *first* with the familiar things of every-day life. I think much more training is to be got by determining, as Prof. Armstrong suggests, the composition of air, the relative combining weights of silver and lead, &c., than by seeing made any number of oxides of nitrogen, and listening to a description of their properties. There is, however, considerable difficulty in arranging easy methods of determining chemical equivalents which, in inexperienced hands, shall give results not *too wide* of the mark.

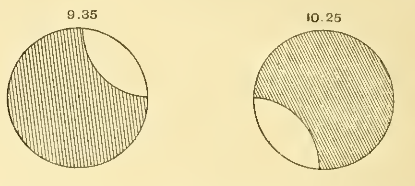
If a boy gets out the atomic weight of oxygen as 9 when the book says it is 16, or finds the latent heat of steam to be 300 and something when it ought to be 536, he begins to disbelieve in the precision of the statements made, and it is unfortunately impossible for a beginner to make *accurate* determinations of combining weights. Less erratic results can, in fact, be obtained in certain selected physical measurements.

The "bareness" of printed instructions is, as Prof. Armstrong remarks, a distinct advantage to the good student, by compelling him to think for himself, but it is fatal to the unintelligent student, to whom "thinking" is the very hardest work he is called upon to do.

SCIENCE MASTER

The Recent Lunar Eclipse

My object in writing is to confirm in some degree the peculiar appearance of the disk, noticed in your last number (vol. xxx. p. 632). The eclipse was seen here under the most favourable circumstances: the obscuration was so great that the disk could barely be discerned with the naked eye, and the copper colour usually seen was not noticed. Having watched the moon well into the umbra, my attention was diverted for a while, but, on looking again, at 9.35 G.M.T., I was surprised to see a portion of the north-east quadrant pretty strongly illuminated; my attention was again diverted, but on looking a second time at 10.35 G.M.T., I observed a portion of the south-east quadrant



illuminated in a somewhat similar manner. At both times the moon was well within the geometrical umbra. But the remarkable feature was that on both occasions the boundaries of the illuminated portions were, approximately, circular, and convex toward the axis of the umbra, indicating that the refracted solar rays producing these illuminations had crossed the axis of the shadow-cone previous to impinging on the lunar disk. The portions of the refracting annulus of the earth's atmosphere concerned in producing these effects were those superincumbent on the Southern Indian Ocean and the North Atlantic.

WENTWORTH ERCK

Shankill, Co. Dublin, November 4

The Sky-Glows

IN using the word "corona" to designate the coloured glare which has accompanied the sun during the past year, I had no intention of employing it in its astronomical sense, but in its ordinary meteorological meaning—which "G. M. H." (NATURE, vol. xxx. p. 633) has overlooked—as referring to the coloured circles on cloud and haze frequently to be seen round the sun and moon, and classed by some observers with halos. By calling the circle now visible round the sun a "corona," I mean that in appearance and probable optical cause it is more like a meteorological corona than like a halo.

May I be allowed to point out a misprint in the first paragraph of my last letter (vol. xxx. p. 633), where it should read "unusual sky phenomena"—the world *universal* having been printed for *unusual*.

T. W. BACKHOUSE

Sunderland, November 8

AFTER sunset this evening there was a peculiar pink flush in the western sky here similar to that which attracted so much attention in England last year. Twenty-five minutes after the sun had gone down, the colour was so vivid as to be reflected from the snows of Mount Baker (10,700 feet), which is about seventy-five miles east of this place. Shortly afterwards it disappeared, but reappeared thirty-five minutes later, prolonging the twilight and making the stars look green, finally dying away very gradually. The weather for the past twelve days has been very wet, and to-night's is the first clear sunset in that time.

Fourteen days ago, when on the Fraser River, eighty miles from here, I saw after sunset a very brilliant aurora borealis. I write this thinking there may be a repetition of the phenomena in England, in which case this note may possess interest.

G. W. LAMPLUGH

Victoria, Vancouver Island, October 13

Peculiar Ice Forms

THE ice structures observed by Mr. Woodd Smith (November 6, p. 5) are evidently the same as were described in vol. xxi. p. 396. I have often seen such fibrous masses since, under circumstances which left no doubt of their being mainly due to prolonged condensation of aqueous vapour from the air; the fibres, white like asbestos, and covered only by a very thin layer of earthy particles, rising from a hard subsoil. The absorption of aqueous vapour by the soil, especially on mountains, seems not yet to be duly appreciated, although it is proved by the many springs issuing at short distances below the summits, and has been insisted upon already in Er. Darwin's "Botan. Garden" and "Phytonomia" (chap. xi. 2). "Rainfall being the source of all water-supply" (NATURE, vol. xxx. p. 375) is a statement hardly to be maintained.

W.

Freiburg, Badenia, November 8

Seismographs—An Apology

I AM just in receipt of the inclosed letter from Mr. Charles A. Stevenson, in which he claims the original idea of the actuating mechanism in the *horizontal component seismograph* I have lately described in these pages, and he includes a copy of his paper to justify his remarks. I therefore think it my duty to offer my apologies to him for not having given him full credit for his invention so far as it goes, although I have *unconsciously* done him wrong. Naples is unfortunately very badly off for modern scientific works and *Proceedings* of Societies, both as regards the National and the University libraries, and as far as I know no copy of Mr. Stevenson's paper exists in the town, except the one he has now sent me.

Perhaps I may be permitted to point out that Mr. Stevenson's seismograph, so far as it is described, would be almost useless for the following reasons:—

(1) The inertia of the upper glass plate would be insufficient not to be affected by the slight movement conducted through the ivory balls to it. This is the reason I use the very heavy lead disk.

(2) No earthquake shock is perfectly horizontal, so that Mr. Stevenson's instrument would only be fit to register the horizontal component of the earth-wave, and would fail to do this, since if the angle of emergence was appreciable it would be jerked up off its supports, and consequently would simply register a series of interrupted lines. This is why I introduced the upper balls and resistance plate.

(3) If the instrument was disturbed by an earth-wave of large amplitude, the registering arm would pass beyond the border of the smoked plate (unless the apparatus was of very great dimensions, so failing to fulfil the conditions of the British Association), where the needle would drop out, or fall so low as to prevent the return of the arm over the plate.

(4) If the earthquake was of some seconds' duration and composed of many varying movements, as is generally if not always the case, a network of irregular curves would remain on the glass that would be quite unintelligible.

If a thing is to be done, it is advisable to do it well, and it is less possible to have accurate registers of earthquake shocks than of the force and direction of the wind, barometric pressure, or any other meteorological phenomena. The requirements of the British Association with regard to expense, size, and portability of seismographs, will not permit anything like an accurate investigation of geodynamics.

In conclusion, should I have overlooked and appropriated the ideas of any other inventor, I shall be happy to fully acknowledge them if sufficient evidence is given (as in the above case) of priority of publication.

H. J. JOHNSTON-LAVIS

November 7

45, *Melville Street, Edinburgh, November* 3

I NOTICED recently in NATURE (vol. xxx. p. 608) an article by you in which you describe a seismograph for recording earthquake shocks, which would appear to be your own invention from reading the paper. No doubt the method of making the record, springs, and upper balls are your own invention, but the *principle* on which the seismograph there described acts is, as far as I know, mine or my father's. I inclose the paper in which it was first described, and I would be glad to learn from you if you forestalled me.

CHARLES A. STEVENSON

Dr. Johnston-Lavis, Naples

Fly-Maggots Feeding on Caterpillars

A FEW months ago I had a caterpillar of *Papilio erythronius*, which I found on a lemon-tree. I put it into a card-box, and fed it daily on lemon-leaves. The box was covered with cloth *tied tightly all round the opening*. After some days, the caterpillar fixed itself to the side of the box, and turned into a chrysalis in the usual way. One day on opening the box, instead of finding the chrysalis changing into its usual colours and markings, it was dark all over. A few days more, on re-opening the box, I found six fully-developed cream-coloured maggots at the bottom of the box. I was rather puzzled to conjecture how these maggots got into a box three inches high, with a bit of cloth tied all round the opening. I put the maggots into a little box with some earth under a tumbler. They immediately buried themselves in the earth. In a few days I found six chrysalides, and some days later there were six ordinary house-flies buzzing within the tumbler. I then examined the dark chrysalis of the *P. erythronius*, which was evidently dead, and found it only a *shell*. All its interior had been consumed by the six maggots. It is evident that these maggots in their infant stage had already been in the body of the caterpillar when I boxed it. The latter had gone through its transformation as if nothing was the matter with it, although, if one could have interrogated it, probably it would have complained of mysterious gnawings and creepings in its interior. A time, of course, came when, for want of nerve-centres and other organs, the chrysalis could not go on with its development into the perfect Papilio. The six maggots having had a full meal, found their way out of the Papilio's chrysalis in order to undergo *their* transformation.

I knew that the larvæ of the Ichneumonidæ fed on the live bodies of caterpillars, but I did not know that the larvæ of the house-fly did so also.

E. BONAVIA

Etawah, India, October 18

THE CRYSTALLINE ROCKS OF THE SCOTTISH HIGHLANDS

EVER since the discovery of Silurian fossils in the rocks of North-West Sutherland, it has been recognised that in that region lies the key to the structure of the Scottish Highlands. Accordingly, when in the progress of the Geological Survey, the mapping of the Highlands had to be undertaken, I determined that a detailed survey of the Sutherland ground on the scale of six inches to a mile should be made as a basis for the work. In the summer of last year a surveying party under the charge of Mr. B. N. Peach was stationed there, with instructions to begin by mapping the Durness Basin. This duty was satisfactorily accomplished before the end of the season. The Silurian series of Durness was ascertained to be about 2000 feet thick, and to consist of numerous successive zones, which were traced on the six-inch maps and discriminated in such a way as to be recognisable should they be found to occur in the more complicated region to the east. With this necessary groundwork well established, the Eriboll tract was attacked this summer by Messrs. Peach and Horne. I had never myself had an opportunity of studying the Eriboll sections, which, from the days of Macculloch down to the present time, have been such a fruitful subject of discussion. It was a special injunction to the officers now intrusted with the detailed survey of the region to divest themselves of any prepossessions in favour of published views and to map the actual facts in entire disregard of theory. By the close of this last season the structure of the Eriboll area had likewise been traced upon the six-inch maps, and I then went north to inspect the work. From time

to time during the summer, reports had been made to me of the progress of the survey, but, though from the published descriptions of that tract, I was aware that its structure must be singularly complicated, and although apprised of the conclusions to which the surveyors, step by step and almost against their will, had been driven, I was hardly prepared for the extraordinary geological structure which the ground itself presented, or for the great change necessitated in the interpretation of the sections as given by Murchison.

No one cursorily visiting the ground could form any notion of its extraordinary complication, which could only be satisfactorily unravelled by patient detailed mapping such as had never yet been bestowed upon it. With every desire to follow the interpretation of my late chief, I criticised minutely each detail of the work upon the ground; but I found the evidence altogether overwhelming against the upward succession which Murchison believed to exist in Eriboll from the base of the Silurian strata into an upper conformable series of schists and gneisses. The nature of this evidence will be best understood from the subjoined report, which, at my request, Messrs. Peach and Horne have prepared. As the question of the succession of the rocks in the North-West Highlands is still under discussion, I think it right to take the earliest opportunity of making this public declaration. It would require more space than can be given in these pages to do justice to the views of those geologists, from Nicol downwards, by whom Murchison's sections have been criticised, and to show how far the conclusions to which the Geological Survey has been led, have been anticipated. When the official memoirs are published, full reference will be given to the work of previous observers, to which, therefore, no further allusion is made at present.

The most remarkable features in the Eriboll area are the prodigious terrestrial displacements, to which there is certainly no parallel in Britain. Beginning with gentle foldings of the rocks, we trace these becoming increasingly steeper on their western fronts, until they are disrupted and the eastern limb is pushed westwards. By a system of reversed faults, a group of strata is made to cover a great breadth of ground and actually to overlie higher members of the same series. The most extraordinary dislocations, however, are those to which for distinction we have given the name of Thrust-planes. They are strictly reversed faults, but with so low a hade that the rocks on their up-throw side have been, as it were, pushed horizontally forward. The distance to which this horizontal displacement has reached is almost incredible. In Durness, for example, the overlying schists have certainly been thrust westwards across all the other rocks for at least ten miles. In fact, these thrust-planes, but for the clear evidence of such sections as those of Loch Eriboll, could not be distinguished from ordinary stratification-planes, like which they have been plicated, faulted, and denuded. Here and there, as a result of denudation, a portion of one of them appears capping a hill-top. One almost refuses to believe that the little outlier on the summit does not lie normally on the rocks below it, but on a nearly horizontal fault by which it has been moved into its place. Masses of the Archæan gneiss have thus been thrust up through the younger rocks and pushed far over their edges. When a geologist finds vertical beds of gneiss overlying gently inclined sheets of fossiliferous quartzite, shale, and limestone, he may be excused if he begins to wonder whether he himself is not really standing on his head.

The general trend of all these foldings and ruptures is from north-north-east to south-south-west, and the steep westward fronts of the folds show that the terrestrial movement came from east-south-east. Corroborative evidence that this was the direction of the movement is furnished by a series of remarkable internal rearrangements that have been superinduced upon the rocks. Throughout the whole region, in almost every mass of rock, altogether irrespective of its lithological characters and its structure, striated planes may be noticed which are approximately parallel with the thrust-planes, and are covered with a fine parallel lineation, running in a west-north-west and east-south-east direction. These surfaces have evidently been produced by shearing. Again, many of the rocks near the thrust-planes, and for a long way above them, are marked by a peculiar streaked structure which reminds one of the fluxion-lines of an eruptive rock. The coarse pegmatites in the gneiss, for example, as they come within the influence of the shearing, have had their flesh-coloured feldspar and milky-quartz crushed and drawn out into fine parallel laminæ till they assume the aspect of a rhyolite in which fluxion-structure has been exceptionally well developed. The gneiss itself coming into the same powerful mill has acquired a new schistosity parallel with the shearing-planes. Hornblende-rock has been converted into hornblende-schist. Moreover, new minerals have likewise made their appearance along the new divisional planes, and in many cases their longer axes are ranged in the same dominant direction from east-south-east to west-north-west.

Murchison believed that the Silurian quartzites and limestones of Eriboll pass up under, and are conformably overlain by, his upper gneiss. It is quite true that they are so overlain; but the overlying rocks, instead of having been regularly deposited on them, have been pushed over them. What, then, are these overlying rocks? Though they have undergone such intense alteration during the process by which they were moved into their present position that their original characters have been in great measure effaced, lenticular bands occur in them which can certainly be recognised. Some of these bands are unquestionably parts of the Archæan gneiss; others are Silurian quartzite, and in one case we can detect a large mass of the Upper Durness limestone. Traced eastwards, however, the crystalline characters become more and more pronounced until we cannot tell, at least from examination in the field, what the rocks may originally have been. They are now fine flaggy micaceous gneisses and mica-schists, which certainly could not have been developed out of any such Archæan gneiss as is now visible to the west. Whether they consist in part of higher members of the Silurian series in a metamorphic condition remains to be seen. The occurrence of a band of crystalline limestone and calcareous schist, which has been traced for many miles above the great thrust-plane, certainly suggests that it represents the upper part of the calcareous Durness series attenuated and altered by the intense shearing which all the rocks have undergone. This much at least is certain, that the schistose series above the thrust-plane is partly made up of Silurian strata, and has received its present dip and foliation since Silurian time.

Having satisfied myself that Murchison's explanation of the order of sequence could not be established in Eriboll, I was desirous to see again, in the new light now obtained, some of the Ross-shire sections for the description of which I am responsible. Had these sections been planned for the purpose of deception they could not have been more skilfully devised. The parallelism of dip and strike between the Silurian strata and the overlying schists is so complete as to prove the most intimate relationship between them; and no one coming first to this ground would suspect that what appears to be a normal stratigraphical sequence is not really so. But the clear coast-sections of Eriboll, where every dislocation is laid bare, have now taught me that I have been mistaken, for the parallelism in question is not due to conformable deposition. The same kind of evidence of upthrust and metamorphism which these coast-sections reveal can be traced southwards for a distance of more

than ninety miles. The task of unravelling the geological structure of these southern regions will be much facilitated by the remarkable persistence of the Sutherland Silurian zones, some of which, with their characteristic features and fossils, are as well marked above Loch Carron as they are at Loch Eriboll.

In south-western Ross-shire the platform on which the Silurian rocks rest is a thick mass of Cambrian red sandstone. In the great upthrow, it is this sandstone platform which has there been pushed over the limestones and quartzites. On the west side of Loch Keeshorn, the red sandstones, in their normal unaltered form, rise up into the colossal pyramids of Applecross; but on the east side, where, at a distance of little more than a mile, they overlie the limestones, they bear so indurated an aspect that they have naturally been classed with the quartzose members of the Silurian series. Traced eastwards they present increasing evidence of intense shearing; fluxion-structure makes its appearance in them, with a development of mica along the divisional planes, until they pass into frilled micaceous schist, in which, however, the original clastic grains are still recognisable. They finally shade upwards into green schists and fine gneiss which merge into coarse gneiss with pegmatite. The short space within which ordinary red feldspathic sandstone and arkose acquire the characters of true schists is a point of some importance in regard to the change from the unaltered Silurian strata of the Southern Uplands into the metamorphic condition of the Highland phyllites, grits, &c.

Obviously the question of chief importance in connection with the structure now ascertained to characterise the North-West Highlands relates to metamorphism. That there is no longer any evidence of a regular conformable passage from fossiliferous Silurian quartzites, shales, and limestones upwards into crystalline schists, which were supposed to be metamorphosed Silurian sediments, must be frankly admitted. But in exchange for this abandoned belief, we are presented with startling new evidence of regional metamorphism on a colossal scale, and are admitted some way into the secret of the processes whereby it has been produced.

From the remarkably constant relation between the dip of the Silurian strata and the inclination of their reversed faults, no matter into what various positions the two structures may have been thrown, it is tolerably clear that these dislocations took place before the strata had been seriously disturbed. The persistent parallelism of the faults and of the prevailing north-easterly strike of the rocks indicates that the faulting and tilting were parts of one continuous process. The same dominant north-easterly strike extends across the whole Highlands, and also over the Silurian tracts of Southern Scotland and the North of England. There is reason to regard it in all these regions as probably due to one great series of terrestrial movements. These must have occurred some time between an early part of the Silurian period and that portion of the Old Red Sandstone period represented by the breccias and conglomerates of the Highlands. In the Central and Eastern Highlands the slates, phyllites, grits, quartzites, and limestones which, along the southern border, are scarcely more altered than their probable equivalents among the Silurian rocks of the Southern Uplands, have been greatly plicated, and have assumed a more or less crystalline structure. But when these changes were brought about, there lay to the north-west a solid ridge of Archæan gneiss and Cambrian sandstone which offered strong resistance to the plication. The thrust from the eastward against this ridge must have been of the most gigantic kind, for huge slices, hundreds of feet in thickness, were shorn off from the quartzites, limestones, red sandstones, and gneiss, and were pushed for miles to the westward. During this process, all the rocks driven forward by it had their original structure more or less completely effaced. New planes, generally parallel with the surfaces of movement, were developed in them, and along these new planes a rearrangement and recrystallisation of mineral constituents took place, resulting in the production of crystalline schists. This metamorphism certainly occurred after early Silurian times, for Cambrian and Lower Silurian strata, as well as Archæan rocks, have been involved in it.

It is obvious that into the problems of Highland geology, always admittedly obscure, a fresh element of difficulty is introduced. At the same time the aid furnished by a minute study of the Sutherland sections is so great that we may hope to attack these problems with more success than has hitherto seemed probable. The work, too, is not of a kind to be attempted in a few hasty scampers over the ground. It will require patient detailed mapping. But when the great base-lines have once been accurately traced, the difficulties will doubtless begin to diminish, and, like the pieces of a puzzle, the various segments of the Highlands will then be found to range themselves in their proper places. ARCH. GEIKIE

Report on the Geology of the North-West of Sutherland

In the north-west of Sutherland the most ancient rocks belong to the Archæan series, and present a great uniformity in lithological characters. They consist mainly of coarse hornblendic gneiss, with distinct zones of gray and pink granitoid gneiss, in which the mica is more abundant than the hornblende. Lenticular veins and bosses of hornblende-rock and hornblende-schist, some at least of which are evidently intrusive, occur in the gneiss, while the presence of small kernels of cleavable hornblende and actinolite forms another characteristic feature of the series. Veins of pink or white pegmatite abound, sometimes parallel with the foliation of the gneiss and sometimes traversing it in all directions. These, however, are distinct from dykes of pink granite, which also intersect the gneiss and coarse pegmatites, and are themselves crossed by later pegmatite-veins. Here and there, indeed, the branches of a pegmatite-vein can be seen to return upon themselves and traverse the main trunk from which they start. Where the Archæan rocks have been recently stripped of their former cover of Silurian quartzite, bands of green epidotic gneiss appear among them, and a soft green mineral with a greasy lustre (agalmatolite ?) is there characteristic of the superficial parts of the pegmatite-veins.

The highly crystalline Archæan rocks are overlain unconformably by a succession of conglomerates, grits, and sandstones, regarded by Murchison as the equivalents of the Cambrian system of Wales. In the course of the work of the Geological Survey in the present region they have been divided into certain zones, which, though they need not be stated here, as they have no bearing on the main question to which this paper is devoted, may prove to be of considerable importance in unravelling the geological structure of the districts further south.

Between the Cambrian sandstones and the overlying quartzites at the base of the Silurian series there is a complete discordance. To the west of the Kyle of Durness, for example, the Cambrian sandstones dip to the north-west, while the overlying quartzites dip to the south of east. Moreover, as the observer passes eastwards to the shores of the Kylê, the Cambrian sandstones are bed after bed transgressed by the quartzites, which eventually rest directly on the Archæan gneiss. The Silurian strata in the Durness area (A in Section) consist of a calcareous series at the top; a middle series, composed partly of calcareous and partly of arenaceous strata; and an arenaceous series at the base. The various sub divisions of the strata are given in descending order in the subjoined tabular statement.

C. Calcareous Series ...	VII. Durine Group ...	Fine-grained, light gray limestones, with an occasional dark fossiliferous band.
	VI. Croisaphuill Group	*c.* Fine-grained, cleaved, lilac-coloured limestones, full of flattened worm-casts; fossils distorted by cleavage. *b.* Alternations of black, dark gray, and white limestone, with an occasional fossiliferous band, like zone (*a*) of this group. *a.* Massive, dark gray limestone, chiefly composed of worm-casts which project above the matrix on weathered surfaces. Near the base are several lines of small chert nodules. This is one of the most highly fossiliferous zones in the Durness Basin.
	V. Balnakeil Group ...	Alternations of dark and light gray limestone, highly fossiliferous, with occasional impure, argillaceous, unfossiliferous bands. Most of the beds are distinctly cleaved, and contain few worm-casts.
	IV. Sangomore Group...	Fine granular dolomites, alternating near the top with cream-coloured or pink limestone. Near the base are two or more bands of white chert, one of which is about 5 feet thick.
	III. Sailmhor Group ...	Massive, crystalline-granular, dolomitic limestones, occasionally fossiliferous, charged with dark worm-castings set in a gray matrix; large spheroidal masses of chert near the base. This limestone is locally known as "the Leopard Stone."
	II. Eilean Dubh Group	Fine-grained, white, flaggy, argillaceous limestones and calcareous shales. As yet no fossils have been found in this division.
	I. Ghrudaidh Group ...	Dark leaden-coloured limestones, occasionally mottled, alternating near the top with white limestone. About 30 feet from the base there is a thin band of limestone charged with *Serpulites Maccullochii*, and a similar band occurs at the base.
B. Middle Series (partly calcareous and partly arenaceous)...	Upper Zone	At the base lies a massive band of quartzite and grit, passing upwards into carious dolomitic grit, crowded in patches with *Serpulites Maccullochii*, more especially in the decomposed portions (Serpulite-Grit).
	Middle Zone	Alternations of brown, flaggy, calcareous, false-bedded grits and quartzites with cleaved shales.
	Lower Zone	Calcareous mudstones and dolomitic bands, weathering with a rusty brown colour, traversed by numerous worm-casts, usually flattened, and resembling fucoidal impressions. These beds are often highly cleaved. This and the overlying zone form the "Fucoid-beds" of previous authors.
A. Arenaceous Series...	Upper Zone	Fine-grained quartzites, perforated by vertical worm-casts and burrows becoming more numerous towards the top of the zone ("pipe-rock" of previous authors). These beds pass downwards into massive white quartzites.
	Lower Zone	False-bedded flaggy grits and quartzites, composed of grains of quartz and feldspar. At the base there is a thin brecciated conglomerate, varying from a few inches to a few feet in thickness, containing pebbles of the underlying rocks, chiefly of quartz and orthoclase, the largest measuring about 1 inch across.

The Silurian strata in the Durness area are arranged in the form of a basin, truncated on the east side by a fault that brings them against the Archæan gneiss, and thus disconnects them from the Eriboll area, with which they were certainly at one time united. Of the identity of these strata in the two areas there cannot be the smallest doubt. We have recognised them zone by zone, completing the proofs of this identity by detecting in the south and central parts of the Durness Basin the representatives of the middle series, viz. the "Fucoid-beds" and "Serpulite-grit," which had not previously been noted in that area. Though subject to local variations in thickness, these zones are singularly persistent, and, from their marked lithological characters and fossil contents, constitute admirable horizons in unravelling the complicated geological structure of the region. A rich assemblage of fossils has been obtained by the Survey from the various fossiliferous bands indicated in the foregoing table, comprising Trilobites, Annelids, Cephalopods (*Nautilus*, *Lituites*, *Orthoceras*, *Piloceras*, &c.), Heteropods, Gasteropods, Lamellibranchs, Brachiopods, Corals, Sponges, and Foraminifera. As yet this collection has not been examined in detail, but from observations in the field it is probable that some of the limestone zones will be found to be characterised by particular fossils.

A striking feature of the Durness Basin is the amount of displacement of the strata by faults; indeed, this feature is so characteristic of the highest limestone zones that it is difficult satisfactorily to compute their thickness. But from the base of the quartzite to the top of the calcareous series the total thickness of Silurian strata cannot be less than 2000 feet. In Sangomore Bay, near the village of Durine, the highest limestone zone is overlain by shattery quartzite, striped fissile schist, frilled schists, and gneiss. Though unquestionably resting upon the limestone and sharing in the normal faulting of the district, these crystalline strata do not prove a conformable upward succession, as has been naturally enough supposed. The key to the reading of this and of the corresponding section at Farrid Head is to be sought in the Eriboll tract.

The Silurian rocks of the Durness Basin are separated from those of Loch Eriboll (B in the Section) by a prominent ridge of Archæan gneiss, the eastern slope of which is covered by a cake of quartzite. Along the crest of the chain the basal breccia is exposed, overlain by the lower zone of false-bedded grits (No. 3) and the upper zone of "pipe-rock" (No. 4 in Section). As the eastern declivity of the ridge is greater than the dip of the quartzites, the observer, on descending the slope, crosses the basset edges and dip-slopes of the latter strata, and eventu-

ally finds himself again on the old platform of Archæan gneiss exposed by denudation (see Section). Both the zones of quartzite are then once more met with in their normal order, the highest beds exposed on the western shore of Loch Eriboll belonging to the horizon of the "pipe-rock." On the eastern shore, at Ant Sron, on the crest of a low anticlinal arch of the "pipe-rock," there is an excellent section of the middle series between the quartzites and the limestones. The two subdivisions of the "Fucoid-beds" (No. 5) and the "Serpulite-grit" (No. 6 in Section), which are typically developed at that locality, pass underneath the Serpulite-limestone at the base of Group I., exactly as they do at Durness. The dark leaden-gray limestones of the lowest group (I.) are then rapidly succeeded by flaggy limestones (Ant Sron, Chorrie Island, Heilim) and dolomitic limestones which, probably the equivalents of the Eilean Dubh Group in Durness, are the highest members of the series here represented (No. 7 in Section). A careful search among the Eriboll limestones has failed to bring to light any organic remains save *Serpulites* and certain minute spherical bodies which may prove to be Foraminifera. A similar dearth of fossils characterises the two lowest zones in Durness, so that this feature is common to both areas. The non-occurrence of the higher fossiliferous limestones in Eriboll may be accounted for by the remarkable geological structure of that region which is now to be described.

As the observer passes eastwards along the magnificent quartzite sections on Crag Dionard and Conamheall, south of Loch Eriboll, he cannot fail to note the numerous flexures of the strata, and especially the peculiar type of their sharp anticlinal folds. As a rule, the eastern limb of each of these folds dips at a gentle angle to the south-east, while the west limb is highly inclined, vertical, even inverted, or sometimes broken by a reversed fault the effect of which is to bring lower over higher beds. These reversed faults (*t t t* in Section) become more numerous eastwards. They are admirably displayed both in ground-plan and dip-section on the shore north of Heilim, where they repeat the various zones ranging from the "pipe-rock" to the Eilan Dubh limestone (Group II.). The strike of the reversed faults ranges on the whole with that of the strata traversed, and their hade is inclined at a higher angle than the dip of the latter, the difference generally amounting to about 10°. Inland from the coast-section, north of Heilim, to the base of Ben Arnaboll, the zones just mentioned are constantly repeated by a complicated system of reversed faults and folds, the general inclination of the strata being towards the south-east. As that hill is approached, the displacement produced by these faults increases in amount; hence the observer meets with beds occupying a lower geological horizon the further east he travels. At length this intricate system of faults and folds culminates in a great dislocation which, for convenience

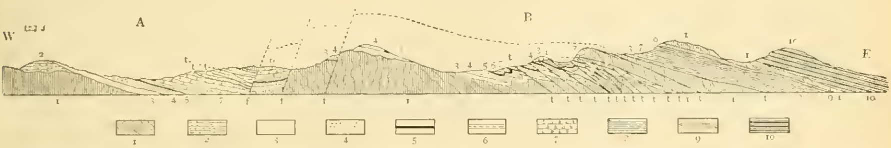


DIAGRAM-SECTION OF DURNESS-ERIBOLL REGION.

10. Gneissose Flagstones, &c. } NEWER GNEISS
9. Siliceous Schist ... ...
8. {Frilled Schist ... ... / Green Schist ... ...

7. Durness-Eriboll Limestone—Upper Series } LOWER SILURIAN SERIES
6. Serpulite-Grit ... ... } Middle ,,
5. Fucoid-Beds ... ...
4. Piped Quartzite ... ... } Lower ,,
3. {False-bedded Quartzite ... / Basal Breccia ... ...

2. Sandstones and Conglomerates—"CAMBRIAN"
1. Gneiss, Granite, Pegmatite, &c. } ARCHÆAN GNEISS

A = Durness Area; B = Eriboll Area; f f = Normal Faults; t t = Reversed Faults and "Thrust-planes"; Dotted lines = continuation of normal faults and thrust-planes.

of description, and to distinguish it from the ordinary reversed faults, may be termed a *Thrust-plane*. By means of it a great mass of coarsely crystalline gneiss with pegmatite-veins, in places upwards of 400 feet thick, is placed above the Silurian rocks (see Section). A careful examination of the mass which caps Ben Arnaboll clearly proves that *it rests transgressively on all the zones of the Silurian rocks, from the lower zone of the quartzites (false-bedded grits) up to the limestone which overlies the Serpulite-grit.* Owing partly to its low hade and partly to subsequent folding, the outcrop of this thrust-plane resembles that of an ordinary overlying formation cut into a sinuous line by denudation. It is admirably seen in dip-section on the east and north slopes of Ben Arnaboll, whence it can be followed round the west face of the hill, descending into the valley on the west, then bending back on itself, winding round the north slope of Druim Tungi, and entering Loch Eriboll in Heilim Bay. It reappears at the base of Crag-na-Faolinn, and has been traced still farther to the south, while northwards it can be followed to the Whitten Head, at the mouth of Loch Eriboll.

That the gneiss thus brought up on Ben Arnaboll and elsewhere is in reality the Archæan gneiss is evident, for two reasons. First, its lithological characters agree with those of the typical Archæan area to the west, save in certain cases where the original features have been effaced by the crushing to be afterwards described. Near the thrust-plane, this effacement is complete, but in the heart of the mass the normal characters of the Archæan rocks, including in some instances their characteristic north-west strike, are retained. The rocks consist of coarsely crystalline hornblendic gneiss and pink granitoid gneiss, with lenticular veins of hornblende-rock and kernels of cleavable hornblende, while massive veins of pink pegmatite are well developed. The soft greenish mineral (agalmatolite?) already mentioned as characteristic of the gneiss, where now or lately covered with quartzite, occurs here in the pegmatites, and veins of epidosite are abundant. Second, at various localities the brecciated conglomerate and false-bedded quartzite at the base of the Silurian strata are found resting on these crystalline rocks. Further, the unconformable junction can on one line be traced continuously for more than a mile. There can be no doubt, therefore, that this mass is really a fragment of the old platform of Archæan rocks on which the Silurian strata were deposited.

The occurrence of this Archæan gneiss in its present position above much younger rocks is doubtless to be ascribed to the same cause which elsewhere has resulted in foldings of the strata. In the present instance we see an attempt, as it were, to establish an anticlinal fold of the type already described as occurring to the west, with a steep westward and gentle eastward slope. The west limb however has here given way along a great dislocation or reversed fault, while the eastern limb has been driven forwards until the Archæan rocks have been carried over the truncated edges of the Silurian strata. The vertical beds of the basal quartzites are still

to be seen on the west limb of the anticline on Ben Arnaboll, Crag-na-Faolinn, and on Whitten Head (see Section). The quartzites on Druim Tungi, and indeed all the Silurian strata on the east side of Loch Eriboll, between Heilim and Crag-na-Faolinn, form part of a syncline which has been pushed westwards in front of the anticline along this thrust-plane. This structure explains the origin of the inversion of the Silurian rocks along the junction line east of Camas-an-Duin, and the occurrence of the lower limestone groups in a shallow trough at Eriboll. Of special interest is the occurrence of a small outlier of Archæan gneiss on the crest of a hill (Sitheanna-Cuag) north-west of Ben Arnaboll. This mass rests on the Fucoid-shales, Serpulite-grit, and limestone. Though now isolated by denudation, it was obviously originally continuous with the mass on Ben Arnaboll, and it thus furnishes striking proof of the westward extension of displaced gneiss, and of the thrust-plane on which it travelled.

The effects of this great movement on the Silurian strata which have been over-ridden by the gneiss are somewhat remarkable. The pipes or vertical worm-tubes in the quartzites have been flattened, drawn out, and bent over in a direction perpendicular to the strike of the thrust-plane. The false-bedded grits and quartzites present a streaky appearance resembling fluxion-structure, due to the elongation of the fragments of orthoclase-feldspar and the quartz grains. The fine-grained rocks, especially the compact quartzites and the Fucoid-beds, are highly cleaved, the strike of the cleavage-planes being parallel with that of the thrust-plane, and this parallelism being maintained quite irrespective of any variation in the direction of dip of the strata next the gneiss. On the surface of the cleavage-planes also there is a series of parallel lines like slickensides which will be described presently; and lastly, there is a slight development of sericitic mica along many of the cleaved surfaces. No less important is the alteration produced on the overlying Archæan gneiss. In the heart of the mass, as already stated, there is little apparent change, but near the thrust-plane the beds are drawn in towards it till their strike roughly coincides with that of the thrust-plane. The inclosed hornblende merges into a green chloritoid product, the hornblendic gneiss has been converted into a fine green schistose rock, while the quartz and feldspar of the pegmatites have been drawn out into streaky or wavy lines, so as to assume somewhat the appearance of rhyolites. Finally a new set of divisional planes has been superinduced on the mass, the strike of which is parallel with that of the plane of thrust.

Again, there is clear evidence to show that the thrust-plane just described was followed by minor movements of a similar nature in the gneiss itself, whereby different portions of the mass were made to slip over each other. Occasionally a thin lenticular mass of the bottom-quartzite has been caught in these planes of disruption.

But all these evidences of displacement are merely the precursors of a still more powerful thrust-plane, which has been traced continuously from the shore east of Whitten Head to the crest of Crag-na-Faolinn, and at intervals for many miles to the southward into the Assynt country. The strike of the strata overlying this plane is, on the whole, north-north-east and south-south-west, with a general east-south-easterly dip, usually at comparatively low angles. Though roughly parallel with it, this greater thrust-plane here and there overrides the lower or more westerly one, for the rocks on its upper side may be seen to pass across all the zones of the Silurian series up to the limestones. A recognisable and tolerably persistent order of succession has been observed in the rocks on the upper side of this thrust-plane. At the base, and resting on different platforms, there usually lies a belt of striped fissile schist, followed by green schist with alternations of gneiss, which, though it has lost nearly all trace of its original foliation, is probably a portion of the Archæan gneiss. A number of lenticular masses of Silurian quartzite occur on this horizon between the Whitten Head coast and Crag-na-Faolinn. In some cases, the basal breccia and portions of the overlying false-bedded grits are clearly seen resting on the Archæan rock, the planes of foliation of the gneiss being roughly parallel with the bedding of the quartzites. On closer examination, however, it is observable that successive folia of the gneiss impinge against the basal breccia. In other cases, wedges of the false-bedded grits, without the basal breccia, are caught between two thrust-planes. Perhaps the most remarkable example of these isolated masses of Silurian rocks, is the limestone intercalated among the green schists, on the hill-slope above Eriboll House. This mass appears to belong to one of the higher limestones of the Durness Basin which have not elsewhere been noticed in the Eriboll area. It lies not far above the great thrust-plane, and though its relations to the schists are not as well shown as could be desired, its presence here is evidently due to the same series of movements that brought in the intercalations of quartzite. Passing eastwards we find, next in order, a belt of frilled green schists (No. 8 in Section) with a well-marked calcareous zone near the top, which has been traced from the shore east of Whitten Head for a distance of ten miles in a south-west direction, and which extends still further to the south. To these succeed a thin band of compact siliceous schists (No. 9 in Section) overlain by hornblendic and micaceous gneiss, which is succeeded by a great development of gneissoid flagstones (No. 10) with occasional bands of hornblendic and micaceous garnetiferous schists.

This order of succession in the rocks above the upper thrust-plane is also recognisable far to the west in Sangomore Bay and on Farrid Head in the Durness area. It is evident that there has been an extraordinary amount of movement of these rocks along the upper thrust-plane, since they override all the other rocks pushed forward by the lower thrust-planes in the Eriboll area, and rest directly on the limestones of the Durness Basin. The thin band of shattery quartzite between the striped fissile schist and the limestone in Sangomore Bay is a fragment of the false-bedded quartzite zone which has been pushed forward along the surface of the thrust-plane,—a characteristic feature of the thrust-planes in Eriboll.

The microscopic characters of the rocks from the different zones above the upper thrust-plane have yet to be studied. Much fresh light may thence be expected on the *modus operandi* of the processes involved in the extraordinary lithological changes which the rocks have undergone. Meanwhile a careful examination of the various masses in the field points very clearly to the nature of these processes. The striped green fissile schist which occurs along the thrust-plane presents an exceedingly compact texture with a remarkable streaked structure which at once recalls the fluxion-lines of an eruptive rock. Still more conspicuously is this structure displayed by the masses of pegmatite in the gneiss; they lose their ordinary character and assume more that of rhyolite. The intercalations of quartzite are marked likewise by the same streaked appearance, their component particles of quartz and feldspar being all elongated in one common direction. The gneiss associated with the schists above the thrust-plane, though its original foliation can still in places be detected, has had a new set of schistose planes superinduced in it which are on the whole parallel with the thrust-plane. Bands of hornblendic gneiss merge into hornblende-schist and chlorite-schist, and these again into finely-frilled schists. All these new structures, which are quite independent of the original bedding or foliation of the rocks, were obviously connected with the production of the great thrust-plane, with which they lie more or less parallel. They point to

enormous mechanical movements under which, as the rocks sheared, the individual particles were forced over each other in one common direction, viz. from east-south-east to west-north-west. Further evidence of this mechanical movement is supplied by certain abundant fine parallel lines, like those of slickensides, which occur almost everywhere on the foliation-surfaces or other parallel divisional planes. They are especially well developed among the striped fissile schists and the gneissose flag-stones. These lines run in the same general direction already mentioned (E.S.E. to W.N.W.). In many cases it may be observed that the component particles of the rocks are oriented in this same direction, while original quartz-veins are drawn out into parallel rods. Another important feature connected with these rocks is the development of minerals along the new planes of schistosity. In particular, the abundance of sericite mica is noteworthy, the longer axes of the crystals of which lie in a direction parallel with the slickenside-lines. Other micas, hornblende, actinolite, and garnets have also made their appearance along the same planes. This re-crystallisation becomes more pronounced the further east one advances from the outcrop, or passes upwards from the great thrust-plane.

This accumulated evidence points to the conclusion that in the north-west of Sutherland the rocks have been powerfully affected by one grand series of terrestrial movements whereby new structures have been super-induced upon them. Among these changes the original characters of the rocks have been more or less completely effaced, and new crystalline structures have been produced. Although a normal upward succession from the Silurian strata into an overlying series of schists cannot be maintained in the north of Sutherland, it is nevertheless certain that the displacements and metamorphism here described are later than Lower Silurian time. It is also evident that these great changes had been completed before the time of the Lower Old Red Sandstone, the conglomerates and breccias of which rest upon and are made up of fragments of the crystalline schists.

One final feature of the Durness and Eriboll area remains to be noticed. The geological structure of this region has been further complicated by the subsequent folding of the strata, and by a double system of normal faults (*ff* in Section) which affect the strata and thrust-planes alike. One set of normal faults trends north-north-east and south-south-west, while another, which appears to be newer, trends more or less at right angles to these. By these two systems of later dislocations, the thrust-planes with their low hade have been intersected and shifted precisely as if they had been ordinary boundary-planes between two geological formations. Much of the difficulty, indeed, which has been from the first experienced in unravelling the complicated structure of this region may be traced to the effect of the intricate network of reversed and normal faulting. The very preservation of the Durness Basin is due to two normal step-faults, one of which lets down the quartzites more than 1200 feet, while the other brings the whole Silurian Basin down to the sea-level.

B. N. PEACH
JOHN HORNE

THE GENESIS OF AN IDEA, OR STORY OF A DISCOVERY RELATING TO EQUATIONS IN MULTIPLE QUANTITY

I VENTURE, even at the risk of appearing egoistical, to call the attention of a wider circle of English mathematical readers than are likely to notice it in the pages of the *Comptes Rendus*, to what appears to me a remarkable discovery in the theory of matrices, or, in other words, of multiple quantity which has lately presented itself to me. It seems to me the more necessary to do so because the nature of the theorem which constitutes the discovery would hardly be suspected from the leading title of the note in the *Comptes Rendus* in which it is contained, being indeed an after-thought, so that the sting of the paper has to be sought for in its tail.

Hamilton, of immortal memory, has given, in his "Lectures on Quaternions," a solution of a certain quadratic equation in *quaternions*, those algebraical entities which (building upon a suggestion in Prof. Cayley's ever-memorable paper[1] on matrices, in the *Philosophical Transactions* for 1858 or thereabouts) I have, with the general concurrence of all who have given attention to the subject, found means of identifying with binary matrices or algebraical quantities of the second order, and thus succeeded in determining the True Place of Quaternions in Nature. Now, what Hamilton has done for an equation of the second degree of quantities of the second order, the theorem in question effects in a much more simple and complete manner for a similar sort of equation of any degree and relating to quantities of any order.

The history of the discovery in question constitutes in itself, it seems to me, an interesting chapter in Heuristic. This is how it came about. Hamilton's equation admits of six solutions or roots, which arrange themselves naturally in three pairs, and stand in immediate, and what we algebraists call rational relation to the three roots of a cubic equation, or rather to the six square roots of those three roots. From this it follows immediately that one single condition must be sufficient to reduce the number of distinct roots of the equation in quaternions or binary matrices from six to four, inasmuch as, when two roots of the cubic referred to become equal, two *pairs* of roots of the original equation must coincide. It naturally therefore became an object of interest to obtain the quantity which, equated to zero, expresses the condition of equality of two roots of this cubic, which of course may be effected by means of a well-known formula for finding the discriminant of a cubic equation; but the quantity so obtained directly from the cubic is of an exceedingly complex form, and leaves the mind entirely unsatisfied as to its true internal composition, just as from a handful of diamond dust it would be impossible to infer the crystalline form which constitutes the true idea, the *raison* or *façon d'être* of the glittering gem.

Again and again my mind reverted fruitlessly to the subject until, on September 28 last, pacing the deck of the splendid Dover and Calais boat, the *Invicta*, under the vivifying and genial rays of a bright and benignant sun, the idea occurred to me that the form to be determined must be subject to satisfy a certain partial differential equation, and without the aid of pen or pencil I succeeded, ere the voyage was half over, in identifying the discriminant of the cubic with that of a biquadratic of the simplest imaginable constitution possible: in technical language, supposing $px^2 + qx + r = 0$ to be the equation in question, I discovered virtually that the desired discriminant is identical with that of the biquadratic form which is the determinant of the binary matrix (or the tensor squared of the quaternion) $px^2 + qx + r$ treated as if x were an ordinary quantity. Starting from this point it was easy to infer all the possible cases of equality which could occur between the six roots; and, more than that, to classify under thirteen classes all the principal cases that could present themselves in the solution of the equation, not merely for the general case when there are six actual and determinate roots, but even for those cases when some of the roots pass off into infinity and become conceptual instead of actual, or else, without passing to infinity, remain actual but contain arbitrary constants.

This more-than-anticipated complete solution of the problem before me was in part suggested by the opening

[1] This paper constitutes a second birth of Algebra, its *avatar* in a new and glorified form. See introduction to "Lectures on Universal Algebra" in the sixth volume of the *American Mathematical Journal*.

lines of a memoir by M. Darboux on the solution of a biquadratic equation in Liouville's journal, with which its eminent author, my colleague in the Institute of France, providentially presented me shortly after my arrival in Paris, and which led me to see that the three pairs of solutions of the Hamiltonian equation must stand in immediate conceptual relation to the three pairs of sides of the complete quadrangle formed by a certain conic related to the form $px^2 + qx + r$ (in fact the determinant of the matrix $pu + qv + rw$) with the fixed conic $v^2 - uw$.

Now comes the turning point, the ἀναγνώρισις of this strange eventful history.

> "There's a Divinity that shapes our ends,
> Rough-hew them how we will." [1]

Seized with a sudden and fortunate attack of bronchitis, which confined me to my bed, and in the access of nocturnal fever which that state induces, my thoughts reverted with increased activity to this geometrical figure. It became clear to my inner sense that there ought to be an immediate relation between the biquadratic determinant of the form $px^2 + qx + r$, spoken of above, and the three pairs of its roots, and seizing my courage with both hands, I made bold to declare to myself that the functional parts of the six *identical equations* to the six roots ought to be the three pairs of conjugate quadratic factors of the biquadratic in question.

But if this should turn out to be true, it became impossible not to suspect, or even more than half believe, that an analogous statement must admit of being made for a unilateral equation (*i.e.* one in which, as in Hamilton's, the multipliers of each power of the unknown matrix x lie all on the same side (whether to the right or left) of it) whatever might be the degree of the equation, and whatever the order of the matrices concerned. In other words, supposing $fx = 0$ to be such equation, and $\phi x = 0$ to be the identical equation to any one of its roots, ϕx ought to be contained as an algebraical factor in the determinant of the matrix fx when, for the moment, x therein is regarded as an ordinary quantity. If this were so, then the reciprocal theorem would necessarily be true (on account of the determinant referred to being in general irreducible), viz. that, supposing ω to be the order of the matrices concerned, every algebraical divisor of it, say ϕx, of the degree ω, must be the identically-zero function to one or the other of the matrices x which satisfy the equation $fx = 0$, and consequently it would be only necessary to combine, according to a well-known method of elimination, the given form fx with each in succession of the derived forms, which constitute a brood or litter as it were, issuing "de son propre sein," to obtain all the roots of fx by solving the ordinary algebraical equation det. $(fx) = 0$, and that thus the solution of the unilateral equation would depend on the solution of an ordinary equation of the degree $n\omega$, n being the degree of f in x, and ω the order of the matrices concerned: the number of the roots of fx would therefore be the number of ways of combining $n\omega$ things ω and ω together, *i.e.* $\frac{\Pi(n\omega)}{\Pi\omega\,\Pi(n-1)\omega}$. But herein arose a self-created difficulty, a phantasmal projection of my own brain, to block up the way, and throw doubt and discredit on all that precedes. Supposing $\omega = 2$, the number of roots thus ascertained would be $\frac{2n(2n-1)}{2}$, or $2n^2 - n$, and for $n = 3$ would be 15. Now, in the *London and Edinburgh Philosophical Magazine* for May last, whilst I had shown that $2n^2 - n$ is the number of roots of a unilateral equation in quaternions of the degree n, and of the trinomial or Jerrardian form, I thought I had proved the number of solutions of a *complete* cubic equation in quaternions to be 21 (upon which I based the formula $n(n^2 - n + 1)$ for a unilateral equation of quaternions of the degree n. There was then the choice to be made —to abandon the conjectural theorem, or to admit an error in the supposed determination of the number 21. I felt no hesitation in making my election, especially as there was a loop-hole for error in such numerical determination, inasmuch as no actual arithmetical calculations had been made, but the order of a certain system of equations which ought to be equal to the number of roots of fx was inferred from calculations in which all numerical quantities were left in blank; it was therefore quite possible (however unexpected the fact) that some of the leading coefficients of the resolving equation of the degree 21 might become zero,[1] and consequently that the order might fall below (although it could not rise above) that number. To my gratified surprise my faith met with its reward, for I soon found an easy proof of the remarkable theorem which I have ventured, in emulation of a phrase of Cauchy, to call a "*pulcherrima regula*," which will appear in the number of the *Comptes Rendus* next forthcoming after this date, and which may be summed up approximately in the following words:—*Every latent root of every root of a given unilateral function in matrices of any order, is an algebraical root of the determinant of that function taken as if the unknown were an ordinary quantity, and conversely every algebraical root of the determinant so taken is a latent root of one of the roots of the given function.*[2] This constitutes a marvellous extension (to a matrix implicitly given by a unilateral equation) of the already no-little-marvellous Hamilton-Cayley theorem of the identical equation to a matrix given explicitly.

My good genius met me on the deck of the *Invicta*, and only left me three weeks later on board the returning steamer from Boulogne. There my pleasing algebraical dream came to an end.[3] J. J. SYLVESTER

New College, Oxford, October 26

[1] It is one of Descartes' "self-evident primary truths" that nothing which has happened could not have happened otherwise.

OUR FUTURE WATCHES AND CLOCKS

HOWEVER long the use of the letters "a.m." and "p.m." for distinguishing the two halves of the civil day may survive, it seems probable that the more rational method of counting the hours of the day continuously from midnight through twenty-four hours to the midnight following may before long come into use for a variety of purposes for which it is well adapted, even if it should not yet be generally employed. It seems proper, therefore, to consider in what way ordinary watches and clocks could be best accommodated to such a change in the mode of reckoning. To place twenty-four hours on one circle round the dial instead of twelve hours as at present seems the most natural change to make; but, in addition to a new dial, it would involve also some alteration in construction, since the hour hand would have to make one revolution only in the twenty-four hours instead of two. And there would be this further disadvantage, that the hours being more crowded together, the angular motion of the hand in moving through the space corresponding to one hour would be less—in fact, one-half of its present amount. It is to be remembered that, in taking time from a clock, persons probably pay small attention to the figures, either those for hours

[1] Or else that its functional part might be composite and throw off an irrelevant factor.

[2] In terms more precise as regards the *converse* the theorem runs as follows:—*The identically-zero function to a root of* fx *is a factor of the determinant to* fx, *and conversely every factor of that determinant of degree equal to the order of* x *is identically zero.*

[3] A letter just received from M. Hermite informs me that M. Poincarré, in a paper presented by him to the Institute on Monday last, takes up the wondrous tale of multiple quantity so largely treated of by me in recent articles in the *Comptes Rendus*. The subject could not be in better hands. The ball is served, and the most skilful and practised players—the Cayleys, the Lipschitzes, the Poincarrés, the Weyrs, the Buckheims (and who knows how many more?)—stand round ready to receive it, and keep it flying in the air.—November 8.

or minutes, the relative position of the hands on the dial probably at once sufficiently indicating the time to most persons without any need of reference thereto, but it would be by no means so easy to pick up the hour from a circle containing twenty-four, and especially in the case of public and turret clocks. There is also the question of change of the motion-work to which allusion has been already made—necessary if the hour-hand is to make one revolution only in twenty-four hours—a practical question in regard to which the watch- or clock-maker could probably best speak.

There is another way of adapting ordinary watches and clocks to the twenty-four hour system, which, if the watch is intended only for the reckoning of local time, seems deserving of consideration. It consists in making the hour figures shorter, not necessarily at all less distinct, and placing two circles of figures round the dial, an inner circle with hours from 0 to 11, and an outer circle with hours from 12 to 23. The hour-hand would thus point to 1 and 13 and to 2 and 14, &c., at the same time, it being understood that the hours 0, 1, 2, &c., would be reckoned in the morning, and the hours 12, 13, 14, &c., in the afternoon, a convention to which people would probably soon accommodate themselves. On such a plan a watch would only require a new dial, no change of wheelwork being necessary, so that it could be very readily applied to existing watches, and so sooner promote the use of the twenty-four hour system. Persons might perhaps object to the introduction of two hour-circles from an artistic point of view. But, after all is said, the question whether one circle containing twenty-four hours, or two circles having twelve hours in each, be preferable, is one to be settled only by a consideration of the relative advantages and disadvantages of the two proposals, in regard to which it would be interesting to learn what business men and others on the one hand, and practical watchmakers on the other, may have to say. There are conditions under which the one circle of twenty-four hours would certainly be the more advantageous, and clearly it would be well that one system only should if possible be used.

As regards clocks, there is the further question of striking the hours. For public clocks we could not go on to twenty-four. It may be a question whether in large towns one stroke only at each hour might not be a sufficient indication, though even this rule probably could hardly be universally applied.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

At a meeting of the General Committee of the British Association held at the Royal Institution on the 11th instant, Sir Lyon Playfair was elected President for the meeting at Aberdeen next year. It was resolved to request the following to accept the office of Vice-President for that meeting:—The Duke of Argyll, the Duke of Richmond and Gordon, the Earl of Aberdeen, the Earl of Crawford and Balcarres, Sir William Thomson, James Matthews, Lord Provost of Aberdeen, Dr. Alexander Bain, Lord Rector of the University of Aberdeen, the Very Rev. Principal Pirie, and Prof. W. H. Flower. The following were elected Local Secretaries: Prof. G. Pirie, Dr. Angus Fraser, and Mr. J. W. Crombie; Local Treasurers: Messrs. Robert Lumsden and John Findlater. The following appointments were also made:—General Treasurer: Prof. A. W. Williamson, Ph.D., F.R.S.; General Secretaries: Capt. Douglas Galton, C.B., F.R.S., and A. G. Vernon Harcourt, F.R.S.; Secretary: Prof. Bonney, D.Sc., F.R.S.; Ordinary Members of the Council: Capt. W. de W. Abney, Prof. W. G. Adams, Prof. R. S. Ball, J. F. La Trobe Bateman, Sir F. J. Bramwell, Prof. W. Boyd Dawkins, Dr. Warren De La Rue, Prof. J. Dewar, Capt. Sir F. J. Evans, Prof. W. H. Flower, Dr. J. H. Gladstone, J. W. L. Glaisher, Lieut.-Col. H. H. Godwin-Austen, J. Clarke Hawkshaw, Prof. O. Henrici, Prof. T McK. Hughes, Dr. J. Gwyn Jeffreys, Prof. H. N. Moseley, Admiral Sir E. Ommanney, W. Pengelly, Dr. W. H. Perkin, Prof. Prestwich, the Right Hon. George Sclater-Booth, Dr. H. C. Sorby, Sir R. Temple; Auditors: John Evans, D.C.L., Treas.R.S., Dr. Huggins, F.R.S., and George Griffith, M.A.

Invitations for the year 1886 were received from Birmingham, Bournemouth, and Manchester, and after a discussion (in which the representatives of Manchester expressed their willingness to withdraw in favour of Birmingham for the year 1886, but their earnest hope that the Association would not fail to visit them in 1887), it was agreed, *nem con.*, to accept the invitation from the town of Birmingham for the year 1886.

The report of the Council relating to the rules concerning the representation of local scientific societies at the meetings of the Association and the establishment of a Permanent Committee as a means of union between them and the Association were sanctioned, and it was resolved in accordance with a recommendation from the Council to present the die for the medal which is about to be founded at McGill University, Montreal, in commemoration of the visit of the Association to Montreal.

THE NEW VOLCANIC ISLAND OFF ICELAND

At the end of July this year the light-keeper at Cape Reykjanes, the south-west point of Iceland, reported that a volcanic island had risen in the sea a few miles off the cape. Reykjanes has long been noted as a centre of volcanic activity, and from time to time islands have arisen and submarine eruptions have occurred in its neighbourhood. In the year of the great Skaptárfell eruption, which proved so fatal to Iceland, 1783, an island appeared off Reykjanes, only to disappear again after a very brief existence. Only a year or two ago an eruption of considerable violence occurred in the sea, not far from the spot where the new island appeared. Columns of steam and clouds of dust, mingled with occasional glowing masses of fused rock, were seen to rise out of the sea, and large quantities of pumice were thrown up and drifted ashore on the neighbouring coast.

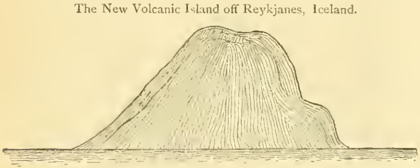
Being desirous to learn as much as possible about the new island, I visited Reykjanes on September 9. The cape, like the greater part of the surrounding district, is entirely covered with lava; not far from the sea lie a number of boiling pools of considerable size, from whose agitated muddy waters arise the columns of steam that give the cape its name, Reykjanes (Smoking Cape); over a large area surrounding the pools the earth is perforated by steam jets and small mud boilers, and the traveller must pass warily over its treacherous surface, for under the thin and yielding upper crust lie beds of soft many-coloured clays, boiling hot, permeated by steam and mixed with sulphur. On a projecting cliff about 150 feet high stands the lighthouse, a low octagonal stone house, and from the point a line of islands, four in number, runs out to the south-west, the nearest being about seven miles, and the farthest about sixteen miles, from the cape. Of these only the nearest two, Eldey or Melsækken (the Meal-sack, so called from the guano deposits that whiten the top of its bleak cylindrical mass), and Eldeyjardrangur, are usually visible from the lighthouse. The farther two, Geirfuglasker and Geirfugladrangur, are chiefly interesting as having been formerly frequented by the Great Auk or Gare-fowl (*Alca impennis*), now apparently extinct.

When I reached Reykjanes, rain and mist obscured the sea, Eldey could only with difficulty be seen, and the new island was quite invisible. I waited patiently for better weather, employing the time in examining the boiling springs and hot clay-beds, which are similar to

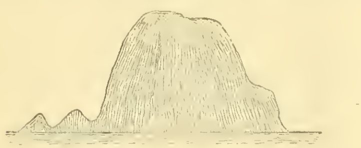
those of the Krísuvík sulphur mines, and the so-called "porcelain rock," a bed of very pure, white, and compact siliceous sinter or geyserite, deposited by some long extinct boiling spring. It was not till the afternoon of the next day that the weather cleared up a little, and a long and patient watch from the top of a hill behind the lighthouse was at length rewarded by the discovery of a dim spot on the horizon, which close observation through a good telescope showed to be the new island. It was quite invisible to the naked eye, but the light-keeper assured me that he had often seen it in clear weather, without a glass. When first seen, on July 29, its shape was that of a truncated cone with a slight depression on the top, and a considerable hollow half way down the slope on the north side.

On August 5 and 6 a series of violent earthquake shocks occurred, which shook and split the masonry of the lighthouse and damaged the lamps. For several days the new island was obscured by mist and rain, and when it again became visible its shape was considerably altered: a large part of the slope on the south side had slipped down into the sea, where it now lies, forming two little hillocks close to the foot of the main mass, and leaving a steep face nearly perpendicular towards the bottom. On the north side there is shoal water extending some distance from the island. The length of the island is about one-third greater than its height. It lies nearly west-south-west of Reykjanes, and considerably to the north-west of Eldey. Two French naval officers who visited Reykjanes and made observations of the island about a fortnight before I arrived there, estimate its distance from the coast at nine or ten miles, but I believe it to be considerably greater. When first seen the island was perfectly black, but now the light-keeper tells me he can in clear weather distinguish by the aid of his glass a perceptible whitening of the upper part, due no doubt to the droppings of the myriads of sea-fowl which frequent the neighbouring islands and coast, and have apparently at once taken possession of the new island.

The New Volcanic Island off Reykjanes, Iceland.



The island as when first seen.



The island as it now appears.

It is a singular fact that none of the usual volcanic manifestations seem to have announced or accompanied the rise of the new island; no earthquakes were felt, no smoke or fire seen, and no pumice found floating on the sea. The island seems to have risen calmly and silently, without a soul being aware of its appearance, till, on July 29, the light-keeper happening to look out to seaward, discovered it. For aught that any one knows to the contrary, it may have been there for many days before he happened to see it. No one has yet visited the island itself; the sea off Rekjanes is almost always rough, and the currents are very strong round the cape; the islands are surrounded by shoals and reefs; landing is at all times difficult and dangerous, even in the best weather, and quite impossible if the sea is at all disturbed; and as, since the discovery of the island, the weather has been for the most part stormy, intending explorers have been deterred by the dangers of the passage. Singularly enough, a French war-vessel and a Danish gun-boat which passed Reykjanes shortly before my visit failed to see the new island. From the direction in which the new island lies, and its apparent distance from the coast, I am inclined to think that it must lie near to the Geirfuglasker (Gare-fowl Skerry), one of the four islands above mentioned, which lies somewhat to the north-west of the line formed by the other three, and which, being low and flat, cannot be seen from Reykjanes. It is not impossible that the new island is merely an addition to or upheaval of the old Geirfuglasker, which, by heightening it so as to make it visible from the shore, would produce the impression that a new island had risen. This view is held by some of the fishermen on the coast who are familiar with the islands, but the point cannot be definitely settled till the island is visited.

W. G. SPENCE PATERSON,
H.B.M. Consul for Iceland

British Consulate, Reykjavík, September 27

TELESCOPES FOR ASTRONOMICAL PHOTOGRAPHY

I.

BEFORE giving any suggestions as to the best kind of telescope to use, and the best methods to follow in the application of photography to astronomical observation and record, it may be more convenient to mention briefly what can be done in this way, particularly as the subject will be new to many who have not followed closely what has been recently done.

I wish to mention (1) That photography has now shown itself to be capable of giving us pictures of nebulæ that are superior to those made by eye and hand. (2) That anything that can be seen by the eye with a telescope of a certain size can be photographed, and, further than this, stars that are too faint to be seen in this telescope can yet be photographed by it with sufficient exposure. (3) That portions of the heavens of several degrees extent each way can be photographed, and stars therein of a magnitude smaller than that shown on the best existing charts or maps, pictured in their proper relative positions and magnitudes in a quicker, better, and more accurate manner than by the plan hitherto used. (4) That it is possible thus to make a complete series of such pictures embracing the whole heavens, that will be practically free from human error. (5) That each individual nebula, cluster, or group of stars, can also be taken on as large a scale as possible, and form a supplement to the picture-maps on the smaller scale. (6) That though such pictures may differ slightly from the eye observations, owing to the different colours of light not affecting the eye and the sensitive plate in the same manner, they would have the enormous advantage that they could be compared directly with other pictures, taken, after the lapse of any number of years, under conditions that there would be no difficulty in making almost identical. (7) That there are other applications of this new power, as in direct enlargements of the surface of the moon piece by piece, of the planets, of double stars, and close clusters, and indirectly in the discovery of planets, either major or minor, by the simple process of direct comparison of star pictures taken at intervals, when the actual position of a planet will be recorded at each date. If there be a planet beyond Neptune, such a plan as this is perhaps the only way to detect it, especially if it is now near the Milky Way, where stars of its probable magnitude cluster so thickly that no process other than this could be used to chart the stars and detect movement. If these things can be done, and I most

confidently say they can, then it must be admitted that nothing short of a revolution in observational astronomy must result, to the enormous gain of astronomy.

I speak relying entirely on my own work and experiments, which I shall refer to in detail further on, and I am strengthened in my opinions by what I hear has been done in a similar direction elsewhere, though I have not, except in one case, seen any of the actual work done.

The possibilities that are thus opened out really border on the marvellous. As has been already said by some one else, a library may now be made, not of books full of descriptions and figures, the accumulated work of many men working many years, each on his own system, but of pictures written on leaves of glass by the stars themselves.

Such a work will mark an epoch in astronomy, and its value increase as long as astronomers exist. No one can doubt for one moment the importance of such a work, nor the fact that, now it is possible, any delay in doing it will be a direct loss to astronomy. How it is to be done—whether by the slow process of letting it be done by the disjointed efforts of many amateurs of astronomy, or by being properly taken in hand and finished by united effort and proper means in the course of a few years—remains to be seen.

I propose to make some suggestions as to the practical part of this work in the selection of the best kind of telescope and mounting, the methods of working, the work to be done, and some other matters in connection. The most important matter is no doubt the selection of the best instrument to work with: of the two kinds of telescopes now in use, the reflector seems to be the most suitable for this work, though a reservation may be made in favour of the refracting principle where large fields on a small scale are required. Both kinds of telescopes when of moderate dimensions, that is, not more than 18 inches aperture, are so nearly alike as optical instruments that the chief distinction worth noting, neglecting for the present one or two points where they differ, and altogether such points as are rather matters of individual prejudice on the part of the observer than qualities or defects in the instruments, is that of cost, the reflector being very much less expensive to make. It is true that the refractor has been hitherto generally considered the most satisfactory in use, and has been preferred when expense has not been a consideration of importance. I think this may be rather due to the greater care that is bestowed upon the more expensive instrument, both in the making of the object-glass and the mounting, than to any real difference that there is between them. The first cost of the raw material alone differs immensely. For the reflector one disk of glass alone is required, and if it is only properly annealed it need not be optically pure. There is only one surface to work, though it is of importance that this should be properly figured, this is not a difficult matter, yet there is little doubt it has often been very imperfectly done in many so-called reflecting telescopes.

For the refractor two disks of glass are required; they must be optically pure, and their first cost alone is more than is often spent on the reflector, including the mounting. These disks must be wrought on four surfaces to proper curves, and time often spent afterwards in perfecting the object-glass; when this is done, the cost is found to be so great that it is felt to be worth a costly mounting. We cannot then be surprised that the better made and mounted telescope should be chosen, but that does not decide the question, Which is the best optical instrument? Nor can this question be decided definitively, because the images formed by each differ. If we look with a reflector at a bright star, the image is seen as an intensely bright point of light, dazzling to the eye if the telescope is large, and we see rays or coruscations round it of an irregular shape that are never steady. I think this effect is not due to the telescope, but is entirely subjective, and caused by this extremely small point of light exciting only a very small portion of the retina; for by proper precautions the light can be reduced, and these rays and the dazzling effect got rid of. With stars less bright it is not so pronounced, and on planets or objects of sensible magnitude it ceases entirely. The image of such a bright star in the refractor is quite of another kind: it is seen as a small disk of light of *sensible diameter* surrounded by the well-known system of diffraction rings and outstanding colour. This disk of light though small, has a different effect on the retina: it can be seen as a shape, pretty steady and free from too much dazzling glare. It is here that the refractor has such an advantage for micrometrical work, permitting bisections to be made with such precision.

The adjustments of the object-glass are considered more constant than those of the speculum, and though the troubles attending the reflector are much exaggerated, they have existed in the arrangements usually adopted. For certain instruments such as the transit-circle, where the connection between the optical axis and some part of the instrument has to be maintained, the object-glass is superior to the speculum; a tilt of the former that would not have an appreciable effect on the position of the image of a star would in the other displace this image twice the amount of tilt.

Both kinds have certain advantages, according to the use they are put to, and it is really not of much consequence which is the best instrument of this size. It is when we begin to consider the effect of increased size and all its attendant difficulties that the question of the suitability of either for the purpose of photography has to be answered.

With the reflector increase of size means proportionate increase in other qualities, in light-grasping power, in defining, and in separating power. With the refractor the greater absorption of light due to increased thickness reduces the light-grasping power, and definition becomes a matter depending not upon the optician but upon the glass-maker; the correction for colour, which even in theory is approximate only, becomes more difficult, and the defects due to the necessarily imperfect correction become more apparent—and these two facts alone show that as the refracting telescope gains in size it becomes more and more unsuitable for photography.

Moreover, when the aperture of the two kinds of telescopes under consideration is the same, the focal length of one must be something like twice that of the other, and that means that the image is four times less bright, and there does not seem to be any indication that the focal length of refractors can be very much reduced. This is only one part of the question, the next and most important one is that of actual cost or difficulty of construction. In the case of the refractor the preliminary difficulty in getting the lumps of glass out of which the lenses have to be made is so great that the increase of the size beyond 30 inches seems at the present moment very doubtful—they may reach 3-foot, or even 4-foot aperture, but it is most unlikely: the cost alone, good or bad, would be simply enormous, and such a size may be for the present left out of consideration. With the reflector the case is entirely different: from what has been said, it is easy to see that the gain by increase of size is proportionate here, and that only mechanical difficulties have to be met. Mirrors of glass covered or coated with silver for the reflecting surface are now in existence of 3- and 4-foot aperture; larger are in hand, and can be made at a cost absurdly below the cost of even a possible refractor: the only limit that I can see here is that of glass, and the limit in this case stops not at 30 inches, as with the refractor, but at something like 70 inches, and that and nothing else of a constructive character prevents the reflector being made much larger, and size is a great

thing in photography. It is, in the case of eye-observation, a fact that you could positively have a telescope too big for the eye to use, but any increase that is at present possible in the reflector would only add to its photographic power.

The optical arrangements of the reflector are so varied that I propose to treat of them in detail for the purpose of indicating the most suitable. A. AINSLIE COMMON

NOTES

THE following is the list of officers, &c., to be proposed at the anniversary meeting of the Royal Society, December 1, 1884:—President, Prof. Thomas Henry Huxley, LL.D. Treasurer, John Evans, D.C.L., LL.D. Secretaries: Prof. George Gabriel Stokes, M.A., D.C.L., LL.D., Prof. Michael Foster, M.A., M.D. Foreign Secretary, Prof. Alexander William Williamson, LL.D. Other Members of the Council: Capt. W. de Wiveleslie Abney, R.E., William Henry M. Christie, Astronomer-Royal, Prof. George H. Darwin, M.A., F.R.A.S., Warren De La Rue, M.A., D.C.L., Robert Etheridge, F.R.S.E., F.G.S., Sir Frederick J. O. Evans, K.C.B., Prof. William Henry Flower, LL.D., Prof. George Carey Foster, B.A., Sir Joseph D. Hooker, K.C.S.I., Prof. Henry N. Moseley, M.A., F.L.S., Hugo Müller, Ph.D., Capt. Andrew Noble, R.A., C.B., Lord Rayleigh, D.C.L., Prof. J. S. Burdon Sanderson, LL.D., Lieut.-Gen. R. Strachey, R.E., C.S.I., Prof. J. J. Sylvester, M.A., D.C.L., LL.D.

PROF. LIVERSIDGE, of the Sydney University, sends to the local press a suggestive communication in connection with the recent meeting of the British Association in Montreal, and the invitation forwarded by the Victorian Premier to visit Melbourne next year. Feeling how insurmountable for the present are the obstacles to such a visit, the writer proposes what appears to be a very wise alternative. Instead of looking forward to a near visit from the Association, he suggests, as a preliminary step, a federation of the various scientific societies in Australia, Tasmania, and New Zealand into an Australasian Association for the Advancement of Science on the lines of the British Association. A first meeting of the new Association might be held in Sydney on the hundredth anniversary of the colony, which with the combined attractions of an International Exhibition might induce a fair number of scientific visitors from England to take part in the proceedings. After the first meeting gatherings could take place annually, or every two or three years, as might be agreed upon by the members, in various parts of Australasia. The writer concludes with the remark, which few will gainsay, that such an Association would tend greatly to advance the sciences in the colonies, and in many ways materially favour their progress elsewhere.

ACCORDING to *Science*, Prof. E. S. Holden, Director of the Washburn Observatory of the University of Wisconsin, has lately collected all the data available for the discussion of the law of distribution of the fixed stars, so far as this is determinable from the method of star-gauging. The data were collected from a comparison with the results of a series of star-gauges in progress with the 15-inch equatorial of the Washburn Observatory; and they included (1) the 683 previously published gauges of Sir W. Herschel, with the places brought down from 1690 to 1860; (2) the 405 unpublished gauges of Sir W. Herschel, extracted from his observing-books, and generously placed at Prof. Holden's disposal by Lieut.-Col. John Herschel (these also reduced to 1860); (3) 500 counts of stars from the published charts of Dr. C. H. F. Peters; (4) 983 counts of stars from the unpublished charts of Dr. Peters, from the Paris charts as revised by him, and from the unpublished ecliptic charts of Prof. Watson; (5) 856 counts of stars from the unpublished and published charts of Dr. J. Palisa. These, with the data from Sir J. Herschel's 605 southern gauges, and Celoria's *Durchmusterung* of the stars between 0° and + 6°, complete the very valuable collection of data which Prof. Holden has brought together in convenient tabular form, and from which one of his most important conclusions is, that the method of star-gauging must be applied to the study of comparatively small regions, and that the results from these are then to be combined into larger groups. Prof. Holden hopes that these tables may serve the valuable end of finally disposing of the fundamental assumption that the stars are equally scattered in space, and may bring about the study of their distribution on a more general basis.

THE Boston Society of Natural History have adopted a policy with regard to their library which, if generally followed, would make scientific libraries more generally useful. The Society send such books as can be replaced to students in any part of the country. The receivers of course pay the cost of carriage, and, in addition, strangers are required to deposit a sum equal to twice the market-value of the books so lent, as a guarantee against loss.

A BUREAU of scientific information has been formed in Philadelphia, composed of officers and members of the Academy of Science, whose duty shall be the imparting, through correspondence, of precise and definite information upon the different departments of science. The organisation is purely voluntary. The Secretary is Prof. Angelo Heilprin, of the Academy of Science.

THE new buildings of the Central School at Paris were opened last week by M. Rouvier, the new Minister of Commerce and Agriculture. A number of speeches were delivered on the occasion, from which we learn that as many as 5000 French engineers owe their training to this institution since its foundation fifty years ago by the late M. Dumas and others. The object contemplated by the erection of this institution was to check the predominatingly theoretical character of the instruction imparted by the Government schools and to remodel the engineering education in France according to the English standard. About ten years ago the establishment was purchased by the Government, but the teachers have held as closely as possible to the lines on which its teaching was originally laid down.

MR. STANFORD, of Charing Cross, has issued a reprint of the paper on the Ethnology of Egyptian Sudán, contributed by Prof. A. H. Keane to the November number of the *Journal* of the Anthropological Institute. This monograph, which will be welcome to all interested in the eventful drama now in progress in the Nile Valley, contains a summary but comprehensive survey of all the races between Egypt and the Equator, which are grouped in five main divisions: Bantu, Negro, Nubian, Semitic, and Hamitic. Much light is thrown on the obscure relations of these peoples to each other, and a clear picture presented to the reader of the manifold ethnical conditions in those regions. The tabulated schemes of all the Sudánese races with their numerous subdivisions, seem to be very complete, and will help to a better understanding of the reports daily received from the scene of the operations undertaken for the relief of Gen. Gordon and the Egyptian garrisons in the Sudán.

THE first annual meeting of the New England Meteorological Society was held in Boston on the 21st ult. The papers read were:—On rain-gauges, by Mr. Fitzgerald; rainfall maps, by Mr. Davis; weather observers in New England, by Prof. Upton; the establishment of a meteorological station on Blue Hill, Mass., by Mr. Rotch.

WITH reference to our recent note to the effect that Prof. Hugo Gyldén, Director of the Stockholm Observatory, had

accepted a professorship at the Göttingen University, we are informed that the celebrated astronomer will, in consequence of the generous offer made to him by the King of Sweden, remain in his native country.

PROF. F. E. NIPHER finds, according to *Science*, from data taken from Dr. Engelmann's observations at St. Louis, Mo., lasting over a period of forty-seven years, that the duration of maximum rains is inversely proportional to the violence, or that the product of violence into duration is constant. This constant is the amount of water which may fall in a continuous rain, and is, for Dr. Engelmann's series of half a century, about 5 inches. A rain of 5 inches per hour may last one hour. A rain of 4 inches per hour may last an hour and a quarter; and such a rain Dr. Engelmann observed. A rain of $2\frac{1}{2}$ inches per hour may last two hours, and several such rains were observed. A rain of 1 inch per hour may last 5 hours. Each of these cases would be a 5-inch rain. For a longer period of time than fifty years it is likely that greater rains than 5 inches may be observed. The same is to be said if observations are to be taken over a wider area of country. In fact, a rain of 6 inches in three hours occurred near Cuba, Mo., some years since. This would increase the value of the constant from five to six, but otherwise the relation will probably remain unchanged. The importance of this law, *Science* points out, is very great in engineering, where the capacity of sewers, culverts, and bridges must be such as to carry the water. A more general investigation which Prof. Nipher is now making will determine the relation between the violence, duration, and frequency not only of maximum but of all rains. This work, when completed, will enable an engineer to construct the water-ways of bridges of such a capacity that they will probably stand a definite number of years before they are washed away. This number of years will be so determined that the interest on the invested capital during the probable life of the bridge will equal the possible damage when the destructive flood comes which the engineer determines shall destroy his work. The running expense of maintaining the bridge is then the least possible.

IN the October number of the *American Journal of Science* Mr. Lewis discusses the validity of observations on supposed glacial action at eleven points in Pennsylvania south of the terminal moraine, all of which he has visited. He concludes that they are all non-glacial, some being simple water-worn gravels, others being ice-rafted boulders, while the scratches reported in two localities are pronounced to be plant-fossils. The glacial action reported in Virginia needs, it is said, similar re-examination.

THE Meudon balloon made its third trial trip last Saturday. Starting at 12.15 noon, when a slight south-west breeze was blowing, it drifted in the direction of the Boulogne racecourse, and after arriving in the vicinity of that place, a distance of about a mile from its starting-point, obeying the motive power controlling its movement, it retraced its journey and alighted at the place from which it had ascended at one o'clock, having thus taken three-quarters of an hour to finish its trip of two miles altogether, going and coming. It is said, however, that the motive power of the voltaic elements was not quite so efficient as had been anticipated.

AT the last meeting of the Geographical Society of Hamburg, Dr. Sievers gave a short sketch of a journey of a year's duration which he intends making in the Cordilleras of Merida in Venezuela. Geographical investigation has, so far, not touched this region. Humboldt travelled through the eastern part from Cumaná to Carácas, the llanos of Carácas and Calabozo, and the districts in the Upper Orinoco, but he did not visit the Cordillera region of Merida. Later travellers also, including Godazzi, whose work was otherwise thorough, did not reach the place. Dr. Sievers will examine the region geologically, and obtain as many measurements of heights as possible.

THE report of a journey from Seul, the capital of Corea, to Songdo, by Mr. Aston, a consular official in Corea, has been published. The difficulties of travel in the country appear to have been much exaggerated; the people are friendly to strangers, and the discomforts are not greater than in China.

ACCORDING to a telegram from Calcutta, Mr. Griesbach, the geologist with the Afghan Boundary Commission, describes the route between Quetta and the Helmund as presenting features very similar to those in the Pishin valley and Candahar, namely, a system of precipitous, deeply eroded ridges, extending from north and south to north-east and south-west. Extensive post-Tertiary deposits fill the intervening valleys. The south-west extremity of the Ghazarband range is composed of sandstone shales and grits of the Flysch facies of Eocene rocks. A series of low hills and valleys stretch between Canjpai and Nushki, which from their composition appear to be merely continuations of the Kojah Amran range, but near Galiahah the formation is distinctly younger, the epoch being mostly trap-rock, which in places bursts through the Cretaceous limestone overlying it, and locally converts it into white marble.

NOT the least valuable of the many excellent reports published in the course of the year by the Chinese Customs department is that of the medical officers on the health of the various ports at which they are stationed. These gentlemen deal frequently with subjects of wider interest than the sanitary condition and health of certain limited portions of the Chinese Empire. Thus in the last reports, Dr. Macgowan, of Wenchow, gives an account of the cholera epidemic which visited China last year. He states, on the authority of a native author, that Indian or Asiatic cholera first made its appearance in China in 1821, medical tradition attributing its origin to the Straits of Malacca, whence it was brought to Fokhien in a junk. It subsequently spread southward to Canton, and from thence to other provinces. In 1825 a great outbreak occurred at Ch'un-Ching. on the Yangtsze, and thence the disease travelled slowly northward, visiting Corea and Japan, where it became extremely virulent. It has since been endemic in China, sometimes becoming epidemic, occasionally extending over the whole of Eastern Asia, and at other times confining itself to a province or part of a province. Dr. Macgowan states that the native doctors treated the disease as common cholera, and did not cure one in a hundred; and he concludes that Indian cholera in China differs from the common cholera of the country only in its epidemic character, the former being migratory, the latter stationary.

IN the *Archives des Sciences physiques et naturelles*, Prof. Forel of Morges has a paper on the solar corona of the spring of 1884, of which the following is a summary. In Switzerland, in the course of the present year, has been observed an extraordinary optical phenomenon consisting of a reddish corona of large diameter surrounding the disk of the sun, as well as of a reddish tint on the white clouds. This corona has been visible since the beginning of the year, and during the months of July and August it was constantly seen. Visible from high altitudes whenever the sky was clear, it was generally lost lower down, hidden probably by the light from lower layers of dust in the atmosphere. The corona is probably occasioned by dust settling in the higher layers of the atmosphere where they are protected from meteorological variations of the lower layers. This dust would be of uniform dimensions, and of a mean diameter of about 0·003 mm. In the absence of any other explanation, M. Forel refers this phenomenon to the brilliant crepuscular illuminations of last winter, and attributes these

luminous objects to the volcanic dust of the eruption of Krakatoa of August 27, 1883. In *La Nature* M. Tissandier describes the corona as observed in two balloon ascents on October 23 and 24.

M. HENRI MAGET is about to publish in Paris an atlas of the French colonies and foreign possessions. The work, which will consist of twenty-five maps, will be brought out with the assistance of eminent French colonial geographers. The maps will be of large size, in three or four colours, and some of them have obtained a silver medal and a diploma of honour, at the recent Geographical Exhibition at Bar-le-Duc. It will be completed in five parts, the first of which has already appeared. This contains maps of (1) New Caledonia, (2) Central Africa (the Congo and the Gahoon), (3) Tonquin, (4) Madagascar, (5) the Grand Duchy of Luxemburg. The second part will contain maps of Réunion, Tahiti, Guadaloupe, Senegal, and the New Hebrides.

WE have again to welcome the appearance of a new edition (the tenth) of Prof. Morren's most useful "Correspondance botanique." Since the appearance of the ninth edition (in 1881) the list of "gardens, chairs, museums, and botanical reviews and societies throughout the world," including also the addresses of all private working botanists known to the editor, has again undergone considerable enlargement—we hope an indication of a gradual spreading of interest in botanical science.

DR. BRUDENELL CARTER has issued in a separate form his now celebrated letter to the *Times* on "Eyesight and Civilisation" (Macmillan and Co.). He has taken the opportunity to introduce a few explanatory diagrams.

PROF. F. W. PUTMAN has sent to the *Leader* a full account of his recent explorations amongst the so-called Liberty Group of Mounds on the Harness estate, Ohio, first surveyed and described by Squier and Davis in 1840. In their great work on "The Ancient Monuments of the Mississippi Valley" these archæologists describe five small mounds within the great square of twenty-seven acres. Most of these, as well as three others represented on their plan just outside a "gateway" on the east side of the larger forty-acre square have been much reduced by cultivation. All have now been carefully examined, two—evidently burial-places—yielding objects of considerable interest. The human bones were much decayed; but amongst the other finds were copper plates, ear-rings, and celts, slate and stone ornaments, some large beads covered with copper, and in one instance with silver over the copper, and many other objects, all of which have been deposited in the Museum of Cambridge University. In another large mound north of the same spot an extensive bed of ashes and charcoal yielded much pottery, pieces of cut mica, some grass matting with charred seeds, nuts, acorns, and bones. Near the eastern corner of the great square stands the largest mound of the whole group, which in future Reports of the Peabody Museum will be referred to as the "Big Mound of the Liberty Group." It is 160 feet long by 80 to 90 wide, and 13 to 18 high, and appears from the portion so far examined to be a burial-place of a remarkable character. Some 40 feet from the centre, at the northern end, twelve chambers were opened, and yielded charred mats and cloth in which the bodies had evidently been wrapped, besides various burnt objects, such as copper plates, ear-rings, shell beads, and long flint knives. In two of the chambers skeletons were found stretched at full length, with a copper plate on one of them, the action of which had preserved the structure of a finely-woven piece of cloth. In the other chambers the bodies had been burnt on the spot, as shown by the relative position of the bones and by the fact that in two instances portions of the bodies had fallen beyond the fire, and so escaped burning. Other discoveries made early in the present year in two of the pits by some boys, under the guidance of Mr. Wilson, yielded a great variety of objects which have also been secured for the Peabody Museum. Important links have thus been obtained between the builders of this great mound and neighbouring earth-works in the Scioto Valley and the constructors of the remarkable group on the Turner estate in the Little Miami Valley.

MR. ELLIS, of 90, New Bond Street, has now on exhibition a number of garments, fur-lined and fur-covered, which were used by the German Polar Expeditions of 1882. In both cases the furs were hardly worn at all. The first expedition, which wintered from August 21, 1882, to September 12, 1883, in Kingawa Fjord, Cumberland Gulf, 60° 15′ W. longitude and 60° 36′ N. latitude, and as there was a perfect calm through the winter, the furs were not necessary; similarly the second expedition, which wintered in the island of South Georgia (36° 5′ W. longitude and 54° 32′ S. latitude) from August 21, 1882, until September 5, 1883, found the temperature equally mild. The furs were lent for exhibition by the Imperial German Polar Commission.

THE last census of Roumania gives a total population of 4,424,961, of which 2,276,558 are males, and 2,148,403 are females. According to religious sects there are 4,198,664 orthodox Greeks, 134,168 Jews, 45,152 Roman Catholics, 28,903 Protestants, 8734 Gregorians, 8108 Armenians, and 1323 Mohammedans. The foreign element in the population is composed as follows:—28,128 Austrians, 9525 Greeks, 3658 Germans, 2822 English, 2706 Russians, 2631 Turks, 1142 French, 167 Italians, and 539 of various nationalities—in all 51,138 persons. The urban population numbers only 781,170, while the rural population is 3,643,783.

ON October 16 a mirage was seen at Lindesberg, in Central Sweden. It represented a large town with four-storied houses, a castle, and a lake. The phenomenon was observed for about fifteen minutes.

THE red sun-glows have recently been observed in the far north of Sweden.

THE additions to the Zoological Society's Gardens during the past week include a Barbary Ape (*Macacus innuus*) from North Africa, an Anubis Baboon (*Cynocephalus anubis*) from West Africa, a Siamese Blue Pie (*Urocissa magnirostris*) from Siam, presented by Mr. R. B. Colom; a Ring-tailed Coati (*Nasua rufa*) from South America, presented by Mr. C. M. Courage; six Alexandrine Parrakeets (*Palæornis alexandri*), a Blossom-headed Parrakeet (*Palæornis cynocephalus*), a Banded Parrakeet (*Palæornis fasciatus*), from British Burmah, presented by Mr. Eugene W. Oates, F.Z.S.; two Ring-necked Parrakeets (*Palæornis torquatus*) from India, presented respectively by Mr. W. G. Burrows and Miss Perry; a Weka Rail (*Ocydromus australis*, white var.) from New Zealand, presented by Mr. J. Satchell Studley; a Brown Capuchin (*Cebus fatuellus*) from Guiana, two Pronghorn Antelopes (*Antilocapra americana* ♂ ♀) from North America, deposited; a Great Grey Shrike (*Lanius excubitor*), six Curlews (*Numenius arquata*), British, purchased; a Blue-winged Teal (*Querquedula cyanoptera* ♂) from South America, received in exchange.

VARIATION OF THE ATOMIC WEIGHTS

THE annexed list contains all the elements except a few very little investigated. If the whole numbers in columns are taken to be each the weight of nine atoms in the gaseous state, and a comparison is made with the best determinations of vapour-densities on record, the result is as follows. The first nineteen determinations are Deville and Troost's, and are to be found in *Comptes Rendus*, xlv. (1857) p. 823; lvi. (1863) p. 893; lx. (1865) p. 1222; lxiii. (1866) p. 20.

	Vols.	Observed at	Calc. sp. gr.	
$3P_6$ =	1		4·433	
		500° & 1040°	4·425	
$3As_6$ =	1		10·529	
		564	10·6	
$3Se_2$ =	1		5·5416	
		1420	5·68	
$3Te_2$ =	1		9·0513	
		1390 & 1439	9·04	
$3Cd$ =	1		3·9253	
		1040	3·94	
$3Al_3Cl_3$ =	1		9·3514	
		350 & 440	9·348	
$3Al_3Br_3$ =	1		18·772	
		440	18·62	
$3Fe_2Cl_3$ =	1		11·3834	
		440	11·395	
$3Ta_4Cl_4$ =	2		9·836	
		350	9·6	
$3Nb_3Cl_5$ =	2		9·5208	
		350	9·6	
$3Nb_3Cl_3O_2$ =	2		7·654	
		440 & 860	7·88	
$3Zr_4Cl_4$ =	2		8·0815	
		440	8·15	
$3Hg_2Cl$ =	2		8·3085	
			8·21	
			8·35	Mitscherlich
$3H_4N_3Cl$ =	4		0·9294	
		350 & 1040	1·005	
$3H_4N_3Br$ =	4		1·7144	
		860	1·71	
$3H_4N_3I$ =	4		2·5457	
		440	2·59	
$3H_3N_3C_4H_5Cl$ =	4		1·4143	
		350	1·44	
$3H_4N_3ClHgCl$ =	4		3·3134	
		440	3·5	
$3H_4N_3HgI$ =	4		6·546	
		350	6·49	
$3Cl$ =	1		2·47	
			2·47	Berzelius
$3Br$ =	1		5·611	
			5·54	Mitscherlich
$3I$ =	1		8·9358	
			8·89	V. Meyer
$3Hg$ =	1		7·0655	
			7·03	Mitscherlich
$3HgCl$ =	1		9·536	
			9·8	Mitscherlich
$3As_6O_6$ =	1		13·854	
			13·85	Mitscherlich
$3P_3S_7$ =	1		7·758	
			7·67	V. & C. Meyer
$3P_3Cl_3$ =	2		4·814	
			4·85	Mitscherlich
			4·875	Dumas
$3As_3Cl_3$ =	2		6·3383	
			6·3	Dumas
$3Bi_3Cl_3$ =	2		11·1871	
			11·16	Jacquelain
$3PbCl$ =	1		9·536	
At 1046°–1089° mean of 4 exp. =			9·5	Roscoe[1]
$3Ti_4Cl_4$ =	2		6·8808	
			6·836	Dumas
$3Sn_4Cl_4$ =	2		9·1898	
			9·199	Dumas
$3Si_4F_4$ =	2		3·6944	
			3·6	Dumas
$3Si_4Cl_4$ =	2		5·9572	
			5·939	Dumas
$3Sb_3Cl_3$ =	2		8·07	
			8·1	Roscoe & Schorlemmer ("Chemistry")
$3Sb_3(C_4H_5)_3$ =	2		7·3773	
			7·438	Löwig & Schweitzer[2]
$3In_2Cl_3$ =	2		7·7698	
			7·87	V. & C. Meyer

[1] *Proc. Roy. Soc.* xxvii. p. 427.

[2] *Journ. Chem. Soc.* v. p. 69.

The agreement in all cases is such that, considering the difficulties with which the determination of vapour-densities is attended, it is not likely that other atomic weights could be chosen to obtain like good results. If now the weights in column *t* are taken to be the weights of a single atom for each element in a certain solid or liquid state, the percentages of oxygen in the following chlorates agree closely with the values found by experiment,[1] to wit:—

$100AgClO_6$	contain	25·0525	O	
	found	25·0795	O	Stas
	,,	25·088	O	Marignac
$100AgBrO_6$	contain	20·34	O	
		20·349	O	Stas
$100AgIO_6$	,,	16·9619	O	
		16·9747	O	Stas
		17·047	O	Millon
$100KBrO_6$	,,	28·7307	O	
		28·6755	O	Marignac
$100KIO_6$	,,	22·4227	O	
		22·473	O	Millon
$100NaClO_6$	,,	45·0672	O	
		45·0705	O	Penny

The agreement in these instances is as good as with the adopted weights; but it is complete also in the following cases, in which there are great discrepancies with the prevailing atomic weights:—

$100PtCl_2KCl$ contain	69·362	$PtCl_2$ and	30·638	KCl	
	69·417	,,	30·583	,,	Berzelius
	69·318	,,	30·682	,,	Seubert
Mean	69·3675	,,	30·6325	,,	
,, ,, yield	...	...	... 117·825	AgCl	
			117·9606	,,	Seubert

The agreement of the mean of the percentages of Berzelius and Seubert with the calculated values is complete; the discrepancy between the amounts of silver chloride is small and within the limits of errors of observation. But the percentages of platinum and chlorine in $PtCl_2$ arrived at by the two experimenters are widely different, viz.:—

40·424 Pt; 28·993 Cl Berzelius
40·107 ,, ; 29·211 ,, Seubert

The true weight of the chlorine follows from Seubert's analysis of the ammonium salt—

$100H_4N_3PtCl_3$ yield 194·954 $(AgCl)_3$
Seubert obtained 192·846 ,,

His rate between the silver chloride and the potassium salt gives ... } Pt = 195·002 Clarke
His rate between the silver chloride and the ammonium salt gives ... } ,, = 196·871 ,, ;

the latter rate is therefore at fault, and 100 parts of the ammonium salt correspond to 194·694 AgCl, if the rate is the same as with the potassium salt; the difference between this number and 194·954 is within the limits of errors of observation. The rate $\frac{100}{194·954} \times (AgCl_3)_3$ gives $H_4N_3ClPtCl_2 = 70·84883$, and the rate $\frac{69·362}{30·538} \times KCl$ gives $PtCl_2 = 53·95833$; H_4N_3Cl is therefore 16·8905, and as the weight of H_4N_3 is not in doubt and = 5·74468, Cl is = 11·14583, as in column *t*. With this weight of chlorine all discrepancies disappear, while the weights recalculated from the same data vary between Pt = 194·314 and 196·871. It is moreover minutely confirmed by the results obtained from all the other elements of the same group.

$100OsCl_2KCl$ contain } 41·0226 Os; 28·5027 Cl; 30·4747 KCl
40·638 ,, 28·9024 ,, 30·4596 ,, Berzeliu

Berzelius's percentage of chlorine is again too large, very nearly to the same extent as the chlorine found by him in the potassioplatinum chloride, while the percentage of the potassium chloride is very exact.

[1] The experimental values are those recalculated by Prof. F. W. Clarke ("Smithsonian Miscell. Coll.," vol. xxvii.).

$100IrCl_2N_3H_4Cl$ contain	44·3691 Pt	
	43·732 ,,	Seubert
$100IrCl_2KCl$ contain	40·3874 ,, ; 28·8097 Cl ; 30·803 KCl	
	39·88 ,, 29·291 ,, 30·82 ,,	Seubert
	29 ,,	Berzelius

The same discrepancies as in the case of the platinum salts present themselves: as the percentage of the potassium chloride is exact, that of $IrCl_2$ follows; and, as to the weight of the chlorine, the difference of the percentages found by the two experimenters shows that there is the same cause of error as in the corresponding platinum salt.

$100PdCl_2.2KCl$ contain	32·678 Pd ; 21·4512 Cl ; 45·8708 KCl	
	32·69 ,, 21·416 ,, 45·892 ,,	Berzelius

The agreement is here as good as complete; but the values actually derived from these data vary from Pd = 104·674 to 110·796, owing to the value of the weight assumed for chlorine.

$100Rh.Na_3Cl_3.Cl_3$ contain—

27·1468 Rh ;	45·6215 NaCl ;	27·2317 Cl	
27·094 ,,	45·577 ,,	27·329 ,,	Berzelius

$100Rh.2KCl.Cl_3$ contain—

29·1276 Rh ;	41·6537 KCl ;	29·2187 Cl	
28·989 ,,	41·45 ,,	29·561 ,,	Berzelius

The agreement is almost complete in the case of the sodium salt, and not doubtful in the other, because the weight of KCl is certain. The values for rhodium derived from the sodium salt are very discordant, varying from 102·98 to 105·696.

$100Ru.2KCl.Cl_3$ contain	28·9984 Ru ;	41·7297 KCl ;	29·2719 Cl	
Numbers actually found	28·96 ,,	41·39 ,,		Claus
Mean of the 3 experiments	28·78 ,,	41·09 ,,	30·17 ,,	Claus

The calculated amount of ruthenium is undoubtedly the actual percentage, because 28·91 Ru were found in the second experiment as 28·96 in the first; and the weight of KCl not being doubtful, that of chlorine can only be as calculated. The results which have been derived from these data are most discordant, viz. Ru 96·854—107·19.

The weights of column *s* give $O_6 = 16$ and $S_3 = 16$; those of column *t*, $O_6 = 15·31914$, $S_3 = 15$. . . . There is consequently a difference of the chemical proportions in the two states which explains many anomalies encountered in analytical work, and among others the following:—Berzelius observes (*Pogg. Ann.* viii. p. 16) that, from causes which he has been unable to discover, the atomic weight of sulphur cannot be derived from the specific gravities of the gaseous compounds H_2S and SO_2, the numbers obtained being so high that the discrepancies exceed the limits of possible errors of observation. He had obtained S = 201·165 from the analysis of $PbSO_4$; Thénard and Gay-Lussac's weighing of H_2S gave S = 203·9; his own weighing of SO_2, 207·58. His weight for O being 100, these 207·58 S represent 407·58 SO_2, which with $S_3 = O_6$ give S = 203·79, practically the same as the value derived from the other gaseous compound. The two numbers 203·9 and 203·79 reduced to the value of the weights of column *t* give respectively 191·056 and 191·053. Berzelius's number 201·165 corresponds to the value of column *t*, H being = 1; with H = 0·95745, the actual weight, it becomes 192·605. The three numbers in hydrogen units—15·292, 15·284, and 15·408—though from different causes all too large, agree with each other as well as can be expected under the circumstances, and the difficulty disappears therefore with the adoption of the weights of columns *s* and *t* for the two different states.

This being so, it is to be expected that for other states the weights will also be still further different, and this conclusion is fully confirmed by the facts. Let the weights of column *t* be = 1, then the weights of the states *a*, *b*, and *c* are as follows:—

$$a = 0·999104 ;\ b = 0·997338 ;\ c = 0·99468.$$

Instead of such loss of weight there may be a gain to the same extent, as, for instance, in the state $\frac{1}{b} = 1·002662$. There are still other variations which are multiples of *a*, *b*, *c*, as—

$$a^{\frac{3}{2}} = 0·99866 ;\ \frac{c^2a}{2} = 0·99424 ;\ cb = 0·99203.$$

The evidence of the reality of these weights appears from the following comparison with some of the very best experiments on record. The numbers marked with an asterisk are derived by the volumetric method, which, in consequence of variation of the atomic weights, yields in all cases more or less faulty results.

$100KClO_6$ contain ...	60·87379 KCl = 1	
	60·81927 ,, = *a*	
Mean	60·84653	
Mean of all experiments on record	60·846 ,,	Berzelius, Penny, Pelouze, Marignac, Gerhardt, Maumené, Stas
100Ag = *c* yield ...	132·8426 AgCl	
Mean of all experiments on record	132·8418 ,,	Berzelius, Turner, Penny, Marignac, Maumené, Dumas, Stas
100Ag correspond to	69·0244 KCl = *a*	
*	69·062 ,,	Marignac
*	69·10345 ,,	Stas
100Ag yield	114·8733 AgS = $a^{\frac{1}{2}}$	
	114·8581 ,,	Dumas, Stas, Cooke
100AgCl yield ...	86·4733 ,, = $a^{\frac{3}{2}}$	
	86·4733 ,,	Berzelius, Svanberg, and Struve
100Ag correspond to	54·1258 NaCl	
	*54·2076 ,,	Pelouze, Dumas, Stas
100Ag yield	157·4707 AgN_3O_6 = *b*	
Mean of 7 experiments	157·472 ,,	Stas
Mean of all experiments on record	157·479 ,,	Penny, Marignac, Stas
$100AgN_3O_6$ correspond to	84·35994 AgCl	
	84·3743 ,,	Turner, Penny
$100AgN_3O_6$ correspond to	43·8331 KCl = *a*	
	*43·8715 ,,	Marignac, Stas
100KCl = *a* yield ...	135·6532 KN_3O_6 = *c*	
	135·6423 ,,	Stas
	135·6345 ,,	Penny
$100KClO_6$,, ...	82·5033 ,,	
	82·500 ,,	Penny
$100NaClO_6$,, ..	79·8917 NaN_3O_6 = $\frac{c^2a}{2}$	
	79·8823 ,,	Penny
100NaCl ,, ...	145·435 ,, = $\frac{c^2a}{2}$	
	145·4164 ,,	Penny
	145·4526 ,,	Stas
$100AgC_4H_3O_4$ = *c* contain	64·6608 Ag	
	64·664 ,,	Marignac
	64·6065 ,,	Liebig and Redtenbach
$100AgC_4H_2O_6$ = *c* contain	59·3367 ,,	
	59·2806 ,,	,, ,,
$100AgC_4H_2O_5$ = *c* contain	62·0621 ,,	
	62·0016 ,,	,, ,,
100BaCl yield ...	138·0494 AgCl	
	138·07 ,,	Berzelius
,, ,, ..	112·251 $BaSO_4$	
	112·19 ,,	Turner
	112·175 ,,	Berzelius
$100CaCO_3$ = *c* yield	56·0312 CaO = 1	
General mean ...	56·0198 ,,	Dumas, Erdman, and Marchand
$100CaCO_3$ = *c* yield	136·0037 $CaSO_4$ = 1	
	136·0525 ,,	Erdman and Marchand
100Pb ,,	146·4418 $PbSO_4$	
	146·4262 ,,	Berzelius, Turner, Stas
100PbO ,,	135·853 ,,	
	135·804 ,,	Turner

100$PbSO_4$	yield	109·2444	$PbN_3O_6 = b$
		109·307	,, Turner
100Pb	,,	159·98	,,
		159·9743	,, Stas
100$PbN_3O_6 = b$	,,	67·3799	$PbO = 1$
		67·4016	,, Svanberg
100AgCl correspond to		29·5607	$LiCl = \frac{1}{b}$
		29·584	,, Mallet, Troost
100Ag correspond to		39·2692	,, $= \frac{1}{b}$
		39·358	,, Stas
100$LiCl = \frac{1}{b}$	yield	162·6508	$LiN_3O_6 = c$
		162·5953	,, Stas
100Tl yield		130·38969	$TlN_3O_6 = b$
Experiment 8 ..		130·3897	,, Crookes
Mean of 10 experiments		130·391	,, ,,
100$G_3O_3(SO_3)_3 . 12HO = c$ contain—			
		14.1694	GO
		14·169	,, Nilson and Pettersson
100$MgC_2O_4H_2O_2 = c$ contain—			
		27·338	$MgO = 1$
		27·3665	,, Svanberg & Nordenfeldt
100$MgCO_3 = c$ contain		47·6	,,
Mean of 19 experiments		47·627	,, Marchand and Scheere
100$H_4N_3 . SO_4 . 3AlOSO_3 . 24HO = cb$ contain—			
		11·2814	AlO
Mean of 10 experiments		11·2793	,, Mallet
100$H_4N_3SO_4 . 3GaOSO_3 . 24HO = cb$ contain—			
		18·9325	GaO
		18·9596	,, Lecoq de Boisbaudran

These determinations include the most classical labours on record, and the general agreement with the calculated numbers is surprising, and the more conspicuous in the cases in which the efforts of the experimenters to exclude error have been pushed to the utmost limits, as in Stas's syntheses and in Prof. Crookes's synthesis of thallium nitrate. Notwithstanding the difficulty in this case, because the element is the heaviest of all so far discovered, one experiment has yielded the identical calculated number, and the mean of all deviates from it only by 0·00131. Moreover the same weights recur in similar compounds; all nitrates, for instance, have a lower value than the corresponding chlorides and sulphates, and the value is the lower the greater the composition, as in the alums. The evidence is such that no doubt seems to be admissible as to the reality of a variation of the atomic weights. This conclusion is independent of any value of the atomic weights; for the discrepancies exhibited in the results of Prof. Clarke's recalculations from the same experimental data above quoted are inevitable if the variation of the atomic weights is not taken into account. In c units Ag is 108·09679 if $H = 1$, calculated from the weights of column t; Cl in the gaseous state is $= 35·66$; the calculated weights correspond therefore, within the limits of experimental errors, to the atomic, but the weights are those of different states.

The difference between the weights of the gaseous and the other states is very considerable; the weight of 3 molecules of $H_4N_3I . HgI$, for instance, is $= 378$ in the state of gas, 354·734 in t units, 352·847 in units $= c$; the discrepancies are so great that they exceed by far the limits of possible errors, and as from the comparisons made it appears certain that the different values are realities, the only explanation is that the atomic weights vary. If in new experiments, in which the possibility of variation is kept in view, all discrepancies which actually exist should disappear, variation will be established beyond all doubt. It will then be in order to inquire into its cause. How the weights of the table have been obtained is, for the present, unessential; it is only necessary to add that column v contains Prof. Clarke's recalculated weights, and column u the same values calculated from the weights of column t, column x giving the number of atoms represented in each instance. Column w shows the corresponding weights of the gaseous state. These columns have been added for the sake of comparison.

	s	t	u	v	w	x
Li	22	2·36559	7·412	7·0235	7·333	3
Ca	58	6·23656	39·0824	40·082	38·666	6
Na	70	7·52688	23·5842	23·051	23·333	3
K	118	12·68817	39·7564	39·109	39·333	3
Rb	256	27·5269	86·2424	85·529	85·333	3
Mg	36	3·8537	24·15	24·014	24	6
Sr	132	14·1303	88·5498	87·575	88	6
Ba	206	20·05183	138·1915	137·007	137·333	6
Pb	306	32·7566	205·2748	206·946	204	6
Ag	324	34·683467	108·6748	107·923	108	3
Cs	398	42·605	133·496	132·918	132·666	3
H	3	0·31915	1	1·0023	1	3
N	14	1·48936	14	14·029	14	9
O	24	2·55319	16	16	16	6
F	58	6·04166	18·93	19·027	19·333	3
Cl	107	11·14583	34·9236	35·451	35·666	3
Br	243	25·3125	79·3125	79·951	81	3
I	387	40·3125	126·313	126·848	129	3
B	11	1·14583	10·771	10·966	11	9
G	14	1·45833	9·072	9·106	9·333	6
C	18	1·875	11·75	12·0011	12	6
Si	22	2·29166	28·722	28·26	29·333	12
Al	28	2·9166	27·416	27·075	28	9
P	32	3·3333	31·33	31·029	32	9
Ti	42	4·375	54·833	49·961	56	12
La	44	4·5833	143·61	138·844	146·666	30
S	48	5	31·33	32·058	32	6
Di	50	5·20833	146·875	144·906	150	27
Yt	60	6·25	88·125	90·023	90	13·5
Yb	62	6·45833	182·125	173·158	186	27
Ce	64	6·6666	139·26	140·747	142·222	20
Sc	66	6·875	43·0833	44·081	44	6
Zr	68	7·0833	88·7777	89·573	90·666	12
Ga	72	7·5	70·5	68·963	72	9
As	76	7·9166	74·417	75·09	76	9
V	78	8·125	50·9166	51·373	52	6
Cr	80	8·3333	52·222	52·129	53·333	6
Mn	84	8·75	54·833	54·029	56	6
Fe	86	8·9583	56·139	56·042	57·333	6
Ni	90	9·375	58·75	58·062	60	6
Co	91	9·4792	59·403	59·023	60·666	6
Sn	92	9·5833	120·11	117·968	122·666	12
Cu	96	10	62·666	63·318	64	6
Nb	98	10·20833	95·95833	94·027	98	9
Zn	100	10·4166	65·278	65·054	66·666	6
Ta	106	11·04166	184·5186	182·562	188·444	16
Se	120	12·5	78·333	78·978	80	6
Sb	126	13·125	123·375	120·231	126	9
W	142	14·79166	185·3888	184·032	189·333	12
Mo	150	15·625	97·9166	95·747	100	6
Cd	170	17·7083	110·972	112·092	113·333	6
In	176	18·3333	114·888	113·659	117·333	6
Th	178	18·54166	232·389	233·951	237·333	12
U	184	19·1666	240·222	239·03	245·333	12
Te	196	20·4166	127·945	128·254	130·666	6
Au	204	21·25	199·75	196·606	204	9
Bi	216	22·5	211·5	208·001	216	9
Ir	300	31·25	195·833	193·094	200	6
Pt	304	31·6666	198·444	194·867	202·666	6
Hg	306	31·875	199·75	200·171	204	6
Os	308	32·0833	201·056	198·951	205·333	6
Ru	318	33·125	103·7916	104·457	106	3
Rh	320	33·3333	104·444	104·285	106·666	3
Pd	326	33·95833	106·403	105·981	108·666	3
Tl	618	64·375	201·708	204·183	206	3

San Francisco, California, July 24 E. VOGEL

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The following gentlemen were on Monday, November 3, elected to Fellowships at St. John's College:—C. M. Stewart, M.A., First Class in Natural Sciences Tripos of 1879, author of several papers on chemical subjects, and Master

at the Newcastle School, Staffordshire; J. Brill, B.A., Fourth Wranger in 1882, Assistant Professor of Mathematics in University College, Aberystwith; W. F. R. Weldon, B.A., First Class in the Natural Sciences Tripos of 1881, author of a number of papers in Zoology and Comparative Anatomy, formerly Demonstrator to the Professor of Zoology and in the Morphological Laboratory; A. R. Johnson, B.A., Sixth Wrangler and First Division in the Mathematical Tripos of 1882–83 (new regulations), author of papers in the *Messenger of Mathematics*, &c.; G. F. Stout, B.A., First Class in the Chemical Tripos of 1881–82 (new regulations), and First Class (with distinction in Metaphysics) in the Moral Sciences Tripos of 1883; G. B. Mathews, B.A., Senior Wrangler in 1884, Professor of Mathematics in the University College of North Wales, Bangor. It is worth noting that Pure and Applied Mathematics, Chemistry, and Biology have been markedly recognised by this election.

Dr. Donald MacAlister has been appointed University Lecturer in Medicine, and Dr. Bushell Annington University Lecturer in Medical Jurisprudence.

Mr. Walter Heape has been approved by the Board for Biology and Geology as Demonstrator in Animal Morphology, on the nomination of the Lecturer in that subject, Mr. Sedgwick.

Prof. Sidgwick, Prof. Adamson (Owens College), and Messrs. James Ward and J. S. Nicholson are appointed Examiners for the Moral Sciences Tripos.

Mr. A. R. Forsyth of Trinity College is appointed Examiner in the Mathematical Tripos (Third Part) in January next, in the place of the late Mr. R. C. Rowe.

In reference to our note a fortnight ago (vol. xxx. p. 649), we should state that, at Trinity College, Major Scholarships of the value of 80*l*. a year, which may be raised to 100*l*. subsequently, are open for competition in Natural Sciences as well as in Classics and Mathematics to persons not yet in residence, with the usual restriction as to age.

SHEFFIELD.—Another step has been taken in the formation of the new Engineering School at Firth College, Sheffield, in the appointment of Mr. W. H. Greenwood to be Professor of Metallurgy and Mechanical Engineering, and Mr. Ripper to be Assistant Professor of Engineering. It may be in the memory of our readers that the City and Guilds of London Institute made a grant about eighteen months ago of 300*l*. a year to the Firth College in aid of the establishment of a Chair of Engineering. Since then additional subscriptions have been promised for five years to the amount of 550*l*., together with a capital sum of over 10,000*l*. A site for laboratories and shops has been obtained, and these will be proceeded with as soon as possible. It is hoped that the special advantages of Sheffield will make it the central school of metallurgy, especially for iron and steel, in the kingdom, and the Committee intend to spare no efforts in rendering it a complete and effective one.

SCIENTIFIC SERIALS

The American Journal of Science, September.—On the amount of the atmospheric absorption, by S. P. Langley. From numerous observations taken at sea-level or at an altitude of nearly 15,000 feet, the author is led to infer that the mean absorption of light as well as of heat by our atmosphere is probably at least double the usual estimate of about 20 per cent. He also believes that fine dust particles, both near the surface and at a great altitude, play a more important part in this absorption, both general and selective, than has been hitherto supposed.—A study of tornadoes, by Henry A. Hazen. In this paper the author examines some of the ordinary theories that are advanced for explaining the origin and development of these destructive phenomena. After showing some of the seeming difficulties involved in these theories, he proceeds to point out a few of the characteristics of the outbursts, with a view to opening up fresh lines of investigation, upon which a further advance may be made towards a true knowledge of the forces underlying them. He is inclined to think that J. Allan Broun's theory, attributing tornadoes to the direct influence of the sun's electricity upon the moisture of the air, or possibly to the indirect effect from the sun's heat, is more satisfactory than the numerous theories of friction, evaporation, condensation, sudden changes of temperature, and the like.—On the absorption of radiant heat by carbon dioxide, by J. E. Keeler. The author considers it probable that to the action of CO_2 in the atmosphere is due one or more of the great gaps in the invisible part of the solar spectrum which the discoveries of Prof. Langley show to be much more extensive than had hitherto been supposed. He further regards it as certain that some other agent than this gas contributes essentially to the total absorptive power of the atmosphere, so that a method of analysis based on this power, in which the effect of the second agent is neglected, cannot lead to correct results.—Note on the Triassic insects from Fairplay, Colorado, by Samuel N. Scudder. These fossil remains present an assemblage of forms altogether different from anything hitherto found in the Palæozoic series on the one hand, or in the Jurassic beds on the other. They seem to show a commingling of strict Jurassic forms with a larger proportion of types which may be called Upper Carboniferous or Permian, with a distinct Jurassic leaning. Hence the probability that the beds in which they occur belong to the Triassic or intermediate formation.—On the flexibility of Itacolumite, by Orville A. Derby. From observations made on this extensive series of quartzose rocks occurring in the gold and diamond regions of Minas Geraes, Brazil, the author infers that the peculiar property of flexibility attributed to them is not an original characteristic, but only a surface character, a phase of weathering or decay brought about by percolating waters.—On the age of the glazed and contorted slaty rocks in the vicinity of Schodack Landing, Rensselaer County, New York, by S. W. Ford.—On the relations of the mineral belts of the Pacific slope to the great upheavals, by Geo. F. Becker. The views of H. P. Blake and Clarence King regarding the parallelism of the series of mineral belts on the Pacific slope to the great mountain ranges, and attributing the deposits themselves to the solfateric action accompanying the ejection of igneous rocks, have since been mainly confirmed. But, independently of any theory, a conclusion of economical importance evidently follows from the fresh facts recently brought to light. A great majority of all the rich ores west of the Wahsatch Range occur in belts following the western edges of distinct geological areas—the Cretaceous in Utah, the Palæozoic and Carboniferous in Nevada and Arizona, the Jura-Trias in East California, &c. Hence analogy points to the neighbourhood of the still unexplored portions of these contacts as the most promising for future discoveries of the precious metals.—Notice of the remarkable marine fauna occupying the outer banks off the southern coast of New England, No. 9, by A. E. Verrill.—Brief contributions to zoology from the Museum of Yale College, No. lv.—Work of the steamer *Albatross* in 1883.—Geology of the Blue Ridge, near Balcony Falls, Virginia, by John L. Campbell.

October.—On the duration of colour-impressions upon the retina, by Edward L. Nichols. Taking up the subject where it was left fifty years ago by Plateau's researches, the author concludes, from a protracted series of experiments: (1) that the study of the duration of colour-impressions produced by different portions of the spectrum tends to confirm Plateau's results; (2) that the persistence of the image is a function of the wave-length producing it, being greatest at the ends of the spectrum, and least in the yellow; (3) that it decreases with the intensity of the ray producing it; (4) that it is not the same for all eyes; (5) that the duration is in inverse order to the luminosity of the colours producing it; (6) that each wave-length of the visible spectrum produces three primary impressions, red, green, and violet, of which the green is the most evanescent, violet the most persistent; (7) that the duration of the retinal image depends upon the length of time during which the eye has been exposed, decreasing as the exposure increases.—Description of a fulgurite from Mount Thielson, Oregon (one illustration), by J. S. Diller.—On the paramorphosis of pyroxene to hornblende in rocks (two illustrations), by Geo. H. Williams.—On the southward ending of a great synclinal in the Taconic Range (with a map and several illustrations), by James D. Dana. The section of the Taconic Range here dealt with extends about 150 miles along the western border of New England, mainly between Middlebury, in Central Vermont, and Salisbury, in North-Western Connecticut. The conclusions arrived at regarding the synclinal character of the system and the Lower Silurian age of the rocks agree with those of Sir William Logan, except that he made the limestone to precede instead of to include the Trenton group.—On supposed glaciation in Pennsylvania, south of the terminal moraine (with a map), by Prof. H. Carville Lewis. The author considers that all the existing surface phenomena may be explained by the action of running waters and other causes independent of glaciation.—History and chemical analysis of a mass of meteoric iron

found in a head-stream of the Red River, Wichita County, Texas, by J. W. Mallet. The analysis yielded iron over 90 per cent., nickel over 8, a little cobalt, tin, phosphorus, copper, sulphur, graphitic carbon, silica, and a trace of manganese.—The life and work of Jean-Baptiste-André Dumas, by J. P. Cooke.—Account of a new meteorite discovered in Grand Rapids, Michigan, on May 15, 1883, by J. R. Eastman. The analysis of the fragment now in the Smithsonian Institute yielded: iron 94·543, nickel 3·815, cobalt 0·369, insoluble residue 0·118.

Rivista Scientifico-Industriale, September 15-30.—Origin of atmospheric electricity, of thunder-clouds and volcanic eruptions, by Giovanni Luvini.—Description of an automatic and continuous registrator of electric energy transmitted at a given part of a circuit, by Prof. Rinaldo Ferrini.—On the electric conductivity of greatly diluted saline solutions, by Dr. Giuseppe Vicentini.—On a system of electro-chronometric bells adapted to private residences, by Giuseppe Bianchedi.—Note on the Walker railway-carriage break, by Angiolo Villa.—On a new system of simultaneous telegraphy and telephony, by M. Van Rysselberghe.—Descriptive notes on the fauna of Sardinia, by Prof. A. Costa.

SOCIETIES AND ACADEMIES

London

Chemical Society, November 6.—Dr. Perkin, F.R.S., President, in the chair.—It was announced that a ballot for the election of Fellows would take place at the next meeting of the Society (November 20).—The following papers were read:—On the action of aldehydes and ammonia upon benzil (continued), by F. R. Japp and S. C. Hooker. In previous papers two general reactions have been studied relating to the joint action of aldehydes and ammonia upon similar bodies; in addition, a third totally distinct reaction occurs, which is investigated in the present paper. The authors have studied the action of salicylaldehyde and ammonia upon benzil. A condensation-product, $C_{28}H_{24}N_2O_4$, was obtained, which proved to be dibenzoyldihydroxystilbenediamine. By the action of dilute hydrochloric acid, the hydrochloride of a new base, $C_{14}H_{16}N_2O_2$, was formed; its platinum salt, picrate, sulphate, diacetyl derivative, &c., were prepared and examined. The authors have also studied the action of furfuraldehyde and ammonia upon benzil.—Isomeric modifications of sodium sulphate, by S. U. Pickering. The author has determined the heat of dissolution of effloresced sodium sulphate heated to various temperatures. He concludes that there are two modifications: one formed by not heating above 150°, the other being produced at temperatures from 150° to the fusing-point of the salt.—On some vanadates of the amines, by G. H. Bailey. The author has prepared and studied a considerable number of these bodies, and has compared them with the corresponding vanadates of the alkalies—Contributions to our knowledge of acetoacetic ether, part 1, by J. W. James.—On magnesium hydrosulphide solution and its use in chemico-legal cases as a source of hydrogen sulphide, by E. Divers and T. Shimidzu. The authors prepare this solution by passing ordinary hydrogen sulphide into a flask containing magnesia suspended in water. By heating the solution to 60°, a steady stream of hydrogen sulphide free from hydrogen and from hydrogen arsenide is obtained.—On the origin of calcium thiosulphate: an emendatory note to a paper on calcium hydrosulphide, by E. Divers. The author concludes that there is essentially only one method of forming the thiosulphate, *i.e.* by the union of sulphur with calcium sulphite.

Physical Society, November 8.—Prof. Ayrton in the chair.—Mr. Kavargee was elected a member of the Society.—Prof. F. Guthrie read a paper on certain phenomena attending mixture. In a previous paper Dr. Guthrie had noticed the increase of volume attending the separation of triethylamine and water effected by heat. The present paper is an account of a more thorough examination of this and allied phenomena. Experiments conducted with a number of different liquids showed that mixtures can be arranged in two distinct classes. Of the first a mixture of water and ether is an example: when shaken up together they mix, heat is *evolved*, and a *diminution* of bulk takes place. If any excess of ether present is poured off, and the lower clear liquid *heated* in a sealed tube, it becomes turbid owing to the separation of the ether. This is accompanied by an *increase* of bulk and *absorption* of heat. Triethylamine and water and diethylamine and water are mixtures belonging to this class; the temperature of separation is a function of the ratio in which the two liquids are present. A typical case of the second class is a mixture of alcohol and bisulphide of carbon. These mix with one another in all proportions above 0° C. with *increase* of bulk and *absorption* of heat. Upon being *cooled* to about −17° C. they separate. The separation of a mixture of ether and water and of a mixture of alcohol and the bisulphide was shown. In these cases the action is regarded as a chemical one, and generally an excess of one liquid or the other is present. To determine the combining proportions two methods were used. In the first a number of mixtures of the same two liquids in different proprtions were taken, and the rise or fall of temperature produced by their mixture measured. When this was a maximum, there might be assumed to be no "dead matter" present. In the second method, which is more delicate, but more laborious, and which was used when the approximate combining proportion had been found by the first, the change of volume produced by mixture was noted; when this increment is a maximum, the liquids are present in their combining proportion. These experiments gave very concordant and definite results: for example, the molecular compound of ether and carbonic sulphide is represented by the formula $C_4H_{10}O,2CS_2$, and that of chloroform and carbonic sulphide by $CHCl_3,CS_2$. A striking confirmation of this view is afforded by the behaviour of the vapour-tension of a mixture. The temperature being constant, if the vapour-tension is plotted with the percentages of the more volatile liquid as abscissæ, the curve is, for a mixture of two liquids which have no chemical action upon one another, as the iodide and bromide of ethyl, a straight line. For ordinary mixtures, however, this is not the case. A curve is obtained in which there is observable at a certain point an irregularity. The corresponding abscissa indicates the molecular combination found by the previous experiments.—Dr. C. R. Alder Wright read a paper by himself and Mr. C. Thompson, on voltaic and thermo-voltaic constants. In a former paper the authors had stated that in a cell set up with two metals immersed in pure solutions of their corresponding salts, a given increment in the strength of the solution surrounding the metal acquiring the higher potential causes an increment (a) in the E.M.F. set up (e), while an increment in the strength of the other solution causes a decrement (b) in the E.M.F. This law is now substantiated; it is, however, found that for dilute acids, instead of metallic salts, (b) may be negative. The authors also find that it is possible to represent the E.M.F. of a cell by the difference of two quantities which they term the voltaic constants. These are quantities, one relating to each plate and its surrounding liquid. The voltaic constant of a metal and a liquid is a function of the nature of the metal surface, the strength of the solution, and the temperature, but is independent of the opposed plate and its liquid; it is practically defined as the E.M.F. set up when opposed to a zinc plate in a solution of the corresponding salt of the same molecular strength. The authors further conclude that the E.M.F. of a given combination usually *stands in no simple relationship to the chemical action taking place in the cell*, but that it may be expressed by the sum of the mechanical equivalent of the chemical action per electro-chemical equivalent, and the difference of two quantities, one being related to each metal and its surrounding liquid, and being constant for that metal and liquid termed *thermo-voltaic constants*. This thermo-voltaic action may act with or against the chemical action in producing E.M.F. In some cases, as in that of a cell composed of iron in ferrous sulphate and cadmium in cadmic sulphate solutions, the E.M.F. is against and greater than that produced by chemical action; consequently the cell works backwards with absorption of heat. At the close of the paper Prof. Ayrton and Dr. Guthrie remarked upon the apparent exception here shown to the second law of thermodynamics.

Paris

Academy of Sciences, November 3.—M. Rolland, President, in the chair.—Observations of the new planet 244 made on October 22 to 24 with the equatorial *coudé*, with remarks on the efficiency of this instrument, by M. Lœwy. The author gives a full account of the performance of this equatorial, which has now been installed in the Paris Observatory for the last two years. His opinion of its excellent qualities is supported by the testimony of Dr. Gill and Mr. Norman Lockyer, the latter of whom pronounces it one of the instruments of the future.—A first study on the parallax of the sun, by M. Bouquet de la

Grye. This paper is based on the calculations made in Mexico by the author and M. F. Arago during the late transit of Venus. From the measurements then taken there results a mean parallax of 8·76 with an apparent approximation of 1/100 of a second.—Studies made at the Physiological Station on the locomotion of men by means of the odograph, by M. Marey. These studies have been undertaken mainly with a view to practical results. One of the objects has been to determine the most favourable conditions under which military forced marches can be accomplished most rapidly and with the least expenditure of muscular energy. The paper is accompanied by two illustrations, showing the readings of the odograph for a man walking at the rate of sixty paces per minute, and the curves of velocity and of the length of stride under various conditions.—A fresh contribution to the study of the Permian reptiles, by M. A. Gaudry.—Note on complex numbers, analogous to the quaternions of Hamilton, by M. H. Poincaré. The various problems connected with this subject are reduced to the following: to find all the continuous groups of linear substitutions variable to n, whose coefficients are linear functions of n arbitrary parameters. This problem is here dealt with.—On the involution of higher dimensions, by M. N. Vanecek.—On some general properties of algebraic surfaces of any degree, by M. Maurice d'Ocagne.—Note on algebraic equations, by M. Berloty.—On the conditions of equilibrium of a liquid mass subjected to electro-magnetic action, by M. G. Lippmann.—Conditions of a helicoidal element for the maximum of efficiency in a screw propeller, by M. Ch. Hauvel.—A comparison of the weighted thermometer with the tubular thermometer, by M. Em. Barbier. The author presents a fresh proof of the proposition already demonstrated by M. Regnault, that if the two instruments agree at the two fixed points, they remain in agreement at all fixed temperatures.—Description of two portable electric lamps, invented by M. G. Trouvé. The author, who gives two illustrations, describes two types of electric lamp, one suited for domestic purposes, the other for workshops, factories, mines, &c. Superiority over all others is claimed for both, on the ground of lightness, portability, convenience, and absolute security even in the most explosive atmospheres.—On the decomposition of the oxide of copper by heat, by M. E. J. Maumené.—Experimental researches on the temporary preservation of various virulent agents in animal organisms, where they remain in a quiescent state, by M. G. Colin. From these experiments it appears that the virus, in passing to animals where it is harmless, may preserve its properties intact for one or two weeks even under unfavourable conditions. It is also shown that in certain refractory cases the virus may give rise to serious and even fatal disorders without any apparent analogy to those caused by it in normal subjects; and further that the same animals may serve several times at varying intervals for the transmission of the poison, although a first inoculation may not have produced in them the attenuating effects of vaccination.—On the employment of the sulphate of copper for the destruction of mildew, by M. P. de Lafitte.

BERLIN

Physiological Society, October 31.—Herr Aronsohn presented a report of experiments which he had instituted in conjunction with Herr Sachs, and which had led to the discovery of a thermal centre in the cerebrum. Starting with the idea that in consequence of a diabetic prick of the medulla oblongata an increase of temperature would manifest itself in the liver, and finding by experiment no confirmation of this conjecture, Herr Aronsohn pushed his investigations for other thermal centres in the brain, and in the course of these researches came upon a spot where, on wounding it with a needle, a very considerable rise of temperature quickly set in. The speaker was not able to specify more exactly the spot at which it was necessary to make the prick in order to produce this effect. It was at all events certain that it was rather limited, and should be determined by more minute anatomical examinations of a number of brains of animals preserved in chromic acid after being operated on. Equally deep pricks made at every other spot of the cerebrum had either produced no effect on the temperature of the body, or had lowered it somewhat. In all the successful cases the corpus striatum was pierced by the needle; in all the unsuccessful cases the corpus striatum remained untouched. There was yet, however, no warrant from this circumstance to conclude where the exact seat of the thermal centre was situated.—Dr. Rawitz described some observations he had made with reference to the copulation of snails, a subject which had hitherto no been investigated. He further communicated from his own experience that snails (*Helix pomatia* and *hortensis*) could, in a state of captivity, be fed on paper. Dr. Kossel confirmed this statement from his own observations, and related that, on feeding snails with highly calcareous paper, abnormal calcareous deposits were observed in their monstrously developed shells.

VIENNA

Imperial Academy of Sciences, October 9.—Preliminary communication on monocyclic systems, by L. Boltzmann.—On the anatomical process of tabes dorsalis, by A. Adamkiewicz.—On double refraction of light in liquids, by E. von Fleischl.—On the comets recently discovered by Barnard (Nashville) on July 16, and by Wolf (Heidelberg) on September 17, and on their ephemerides and elements as computed by K. Zelbr at the Vienna Observatory, by E. Weiss.—On the development of the walls of arteries, by B. Morpurgo.—On the perception of sound, by E. Bruecke.—On the action of benzoyl-hyperoxide on amylene, by E. Lippmann.

STOCKHOLM

Society of Natural Sciences, October 18.—Prof. Sandahl, President, in the chair.—On foreign physiological institutions, by Dr. Tigerstedt. Referring to the development of physiology during recent years, the speaker described some of the principal institutions abroad, having visited forty of this kind. A similar one, on a smaller scale, was being established at the Carolina Institute in Stockholm.—The President, announcing the death of Dr. Regnell, the Brazilian Mæcenas, referred to the valuable botanical collections he had presented to the Upsala University.—Prof. Aurivillius exhibited a collection of butterflies, preserved by Herr E. Holmgren by removing the intestines and inflating the specimens. They were in splendid condition, the colours being particularly bright.—On the habits of the eider-duck and the dottrell, by Dr. Sundström. The speaker stated that careful study had proved that the eider-hen does not, as is so generally supposed, take her young during the summer into the ocean, but remains among the islands on the coast. The bird had greatly increased in the south of Sweden during the last few years.—On thunderbolts, by the same.—Herr Neves reported the receipt from Finland of eggs of the eagle, *Aquila clanga*, and the snipe, *Terekia cinerea*.

CONTENTS

THURSDAY, NOVEMBER 20, 1884

BACTERIOLOGY

AMONG the most striking of the recent rapid advances of science is the development of what we may term bacteriology. For more than one hundred years a debate had been going on as to the origin of the minute forms of life which were present in decomposing organic materials, but till the publications of Cagniard-Latour and Schwann no part was assigned to them in the production of the chemical changes which these materials undergo. It was not, however, till the publication of Pasteur's papers on the alcoholic fermentation and on spontaneous generation little more than twenty years ago that any sound basis was obtained for the idea that a micro-organism was able to cause fermentation. The science of bacteriology really dates its commencement from the first publication of Pasteur's papers. Following rapidly on this work, researches have been carried on which have now demonstrated that all the fermentations belonging to the same class as the alcoholic fermentation are due to the development of micro-organisms, and that bacteria are most important factors in Nature, being the chief agents by which the complex organic constituents of plants and animals are brought back to simple forms capable of serving again as food for plants.

But the researches have not been confined to the study of fermentations. In 1851, Rayer and Daraine observed in the blood of animals suffering from splenic fever the presence of numerous small rods which were supposed to be crystals. On the publication of Pasteur's papers, Daraine again took up the subject, and came to the conclusion that these rods were bacteria and the cause of the disease. For some years little was done in this direction, though microscopical observations on the occurrence of bacteria in various diseases were described. With the publication of the investigations of Koch and Pasteur on anthrax, and more especially of Koch's modes of cultivation, a new start was made, and these researches have since been carried on with a certainty and a precision that could not have been anticipated, and have led to the accumulation of a large amount of knowledge with regard to the causation of infective diseases. A causal relation has been established between bacteria and splenic fever, various septicæmic affections, and infective diseases in the lower animals, tuberculosis, glanders, erysipelas, and other diseases in man; while in a number of other cases, in which the causal relation has not been completely demonstrated, facts have been made out which render it extremely probable. In spite, however, of this large addition to our knowledge, the subject is as yet little more than in its infancy, numerous questions of the greatest importance and likely to lead to the most important results still requiring investigation.

Apart from its purely scientific interest there is perhaps no department of science which so nearly concerns the health and well-being of the community, and already important practical results have been obtained, affecting medicine, industry, and public health. Following closely on Pasteur's early publications, and as a direct result of them, we have the great revolution in surgery brought about by Sir Joseph Lister, resulting in such improvements in the management of wounds as have been the means of saving numerous lives and of greatly enlarging the scope of surgical interference. Our knowledge of the value of disinfectants, of the mode of spread of infective disease, and of the precautions necessary to prevent its spread has also been very largely increased, and must lead to great improvements in hygiene. Nor must we omit to mention the valuable experiments begun by Toussaint and Pasteur, and now being carried on to a large extent by Pasteur, on the attenuation of virus and the conversion of virulent micro-organisms into useful vaccines. This has been demonstrated to be possible in the cases of chicken cholera, anthrax, pig typhoid, and possibly hydrophobia, and has been put practically into force in France in the case of the first three affections. Useful facts affecting various industries have also been made out. The deplorable condition of the silkworm industry some years ago and Pasteur's investigations thereon are well known, and have led to the restoration of the silk manufacture; while his work on diseases of beer and wine, and the work of others on various fermentations, have proved of the greatest benefit.

While some of this work has been done in this country, by far the greater part has been done abroad, more especially in Germany and France, where its importance is recognised, and where special facilities are afforded by the Governments and various public bodies. In Germany especially, besides the laboratory, supported by the Government, in which Dr. Koch works, a number of similar institutions are being established throughout the country; and in France the laboratories of Pasteur and others are established and supported by the Government and by various municipal authorities, every facility for carrying on these researches, and the necessary funds, being provided. In this country, on the other hand, there is no laboratory of the kind, and what work has been done has been by individual investigators working at their own expense, and often without suitable accommodation. To carry on this work a considerable amount of apparatus is necessary, an assistant is required, and the use of a laboratory where animals can be kept is essential. Without the help of a trained assistant, the investigator's time must be largely taken up in the sterilisation and preparation of his cultivating media and in other manual work, leaving but little time for actual investigation, more especially if, as is often the case, teaching or medical practice must be carried on as well in order to earn a livelihood. How different are the conditions where a well-equipped laboratory is provided, where trained assistants are present, and where a salary is given sufficient to enable the investigator to devote his whole time to the work. Surely it would be possible to establish a proper laboratory in this country.

That the matter is felt to be of importance was shown last summer by the fact that the Executive Council of the Health Exhibition devoted a considerable sum to the establishment of a model laboratory under the direction of Mr. Watson Cheyne, in which many of the results and the most recent methods of investigation were shown. This laboratory was visited by large numbers of scientific men and others, and the hope was universally expressed that the model would become the basis of a permanent institution. We

are glad to hear that the Executive Council of the Exhibition are taking into consideration the advisability of devoting their surplus funds to this object, and we hope that they may ultimately resolve to do so. They could not better advance the cause of hygiene, and more fittingly carry on and perpetuate the work begun by the Exhibition. The sum required to build and adequately endow such a laboratory would of course be considerable, but there can be little doubt that, once the matter is started, various public bodies will aid in the work, while a suitable site at South Kensington might be obtained from the Commissioners, as there the laboratory would be in the vicinity of those belonging to the Science and Art Department and the City and Guilds Institute.

HEROES OF SCIENCE

Heroes of Science: Mechanicians. By T. C. Lewis, M.A. (London: Published under the direction of the Society for Promoting Christian Knowledge, 1884.)

IN this volume short histories are given of the following inventors:—Watt, George Stephenson, Richard Arkwright, Crompton, Maudsley, Joseph Clement, James Nasmyth, Whitworth, and Babbage. The facts told of the lives of these men have been gathered from reliable sources and are accurate. It is unfortunate that Prof. Lewis did not introduce more of these facts in his book instead of using up its very limited space by inserting an inordinate amount of moralising, which is extremely tantalising, and makes it often difficult to proceed owing to the impatience which it causes. No words that could be used by way of reflection, even by a great writer, could add much to the moral stimulus afforded by the simple narrative of the lives of men like Watt and Stephenson, and the style which we encounter here, although often very ambitious, signally fails in attaining its mark and, instead of increasing our admiration for the men described, adds an unwelcome tinge of the ridiculous to the account. Thus in describing the early life of Arkwright we meet with these sentences amongst others:—"Before this he was probably as well off as most itinerant dealers in hair of his rank, but this first decisive step of his" [that from a village barber to a dealer in hair] "was enough to show that he could be dominated by an idea even to the length of relinquishing some certainties of advantage." "Whilst he was doing his unexciting work of preparing orderly cover for the outside of other men's heads" [this means making wigs] "he was—apparently too without much mental excitement—introducing order and exercising thought in the interior of his own; in consequence of which it appears that, whatever he did in those days to cover the heads of thinking and thoughtless men and women with a fair show of hair, he has done more for us in providing for the inside of ours some furniture of profitable thought," &c.

Amongst many curious pieces of information which we come across we may draw attention to the following piece of social history probably hitherto unknown. "When Adam delved and Eve span, or when their descendants first adopted this division of labour, the work of digging was carried on in the sweat of the brow, it required strength, and was relegated to the man; the process of spinning, which required less strength than dexterity, was assigned to the woman." Neither in Genesis nor in the *Transactions* of the Anthropological Society do we remember having seen any account of this early example of the division of labour. Valuable practice in English construction after the manner of the old so-called orthographical exercises, might be set on this book, by asking boys studying English to criticise and explain (if possible) the meaning of the phrases in italics in the following sentences:—(Page 155) "In him we look in vain for *the disinterestedness that endears self-sacrifice to us.*" (P. 253) "The revolution that was being effected by the introduction of machine tools, was, like all revolutions, sure to meet with resistance. It is not too much to say that by its means *a little one became a thousand.*" As a piece of grandiloquent writing, of which we here find many samples, we may instance this (p. 211):—"Modern inventions succeed one another like the links of a golden chain forged by men of god-like skill for our support, and indeed for our elevation. The cloak of an Elijah often falls upon the shoulders of an Elisha."

We are curious to know if the assailers of classical education have ever used stronger language than is here employed in describing Nasmyth's studies (p. 212):—"The classical education they had attempted with little success to give to him there was not at all suited to his bent. He asked for food, and they gave him a nauseous poison." In these days when the working man is so courted and admired, we should have thought it, to say the least, unnecessary to inform the readers of this book that (p. 202) "in all his (Clement's) work . . . there was an interest in his art which in his case raised it above the labour of a calling," or (p. 232), "in labour such as his (Nasmyth's) there was no degradation" This too after he had become an employer of labour himself!

Besides committing great errors of style, the author occasionally errs as to matters of fact. Thus (p. xiv.), he says, "The world has had to be content with using from two and a half to four pounds of coal for" one horse-power. The limit would have been put much lower had he studied the records of the engines of the best American liners. On p. 57 a description is given of "the double-acting steam-engine, in which steam is admitted to press the piston both upwards and downwards, the piston being also aided in its motion by a vacuum produced by condensation on the side towards which the steam is pressing it." To say that the piston motion is "*aided*" by the vacuum on the opposite side to that on which steam is acting is a curious way of representing the fact that without such a vacuum no motion of the piston would be *possible.* The definition of parallel motion given is new. On p. 58 we read, "The specification included . . . the contrivance for parallel motion or for making the piston-rod move perpendicularly up and down without chains or perpendicular guides, or untowardly friction, arch heads, or other pieces of clumsiness."

The book, which we are informed (p. vi.) is intended for boys, does not give enough explanation. The descriptions of inventions given are of the briefest, and will be quite unintelligible to any one who has not already spent a considerable amount of time in studying them elsewhere. If Prof. Lewis had been content to omit the wearisome reflections which he has placed in the book, and had,

instead, inserted a few engravings, he would have made the book more entertaining and less trying to readers of only average patience. If he had spent more time on the solid parts, and less on its affected adornments, he would have produced a valuable and interesting book.

OUR BOOK SHELF

The Student's Guide to Systematic Botany. By Robert Bentley, F.L.S., M.R.C.S. Engl., &c. (London: J. and A. Churchill, 1884.)

THIS little book, which aims chiefly at supplying the wants of medical and pharmaceutical students, represents fairly what was the state of systematic botany in England twenty years ago. The bulk of the book is occupied with a detailed description of the natural orders of Phanerogams, while the Cryptogams are dismissed in fourteen pages. But it is not only by the very cursory way in which these plants are treated that the student is led to underrate the importance of the morphological differences by which the various groups of Cryptogams are distinguished; the heterogeneous series of Algæ and Fungi are described as "orders" comparable, as regards the terms used in the classification, with the orders of the Angiosperms. Again, in the text, signs of antiquity are numerous: for instance, in distinguishing the Cryptogamia from the Phanerogamia (p. 14) we find that the former "are reproduced by spores, and are therefore acotyledonous," a sentence which implies that the spore is the homologue of the seed! In describing the ferns no mention is made of the prothallus, antheridia, or archegonia, though the latter are described as occurring in the mosses, and resulting in the formation of a "sporangium." These examples are sufficient to show that this book does not meet the present requirements even of medical students, who now have access to other text-books, treating of the principles of systematic botany in a manner more in accordance with the present state of the science than the "Student's Guide" of Prof. Bentley.

The Electrician's Pocket-Book. The English Edition of Hospitalier's "Formulaire Pratique de l'Électricien." Translated, with additions, by Gordon Wigan, M.A., Barrister-at-Law. (London, Paris, and New York: Cassell and Co., Limited, 1884.)

M. HOSPITALIER'S "Formulaire Pratique de l'Électricien," of which the work before us is a translation, has become well known in this country as a useful compendium of data and rules for electrical work, and Mr. Wigan has done good service in putting an English version within the reach of the numerous class of practical men whose knowledge of French is, to say the least, limited. He has executed his task very creditably, as the book, so far as we can tell without a minute examination of the numerical and other data, seems fairly accurate and trustworthy. The least satisfactory part of this work, as of all others of the same kind which we have seen, is, we think, the synopsis of theory which is given along with the data and other practical information. In these days of excellent elementary and advanced text-books of theoretical and to some extent also of applied electricity, the necessarily detached and somewhat scrappy statements of theory which partly fill the "pocket-books," are little called for, and the space occupied by them could be used to better advantage for other matter, or the book lightened by their omission.

In looking over the book we have found some slight faults in descriptions of instruments, &c., which might be mended in a new edition. For instance, in p. 75, the author (? translator) has entirely misapprehended the use of the V-groove in Sir W. Thomson's "hole, slot, and plane" arrangement for insuring that an electrometer or other instrument is replaced, after being moved, in exactly the same position. The "hole" is not simply a hole, but a conical hollow, and the primary object of having a V-groove is to obviate the infinitely perfect fitting which a second hollow would render necessary. Again, the description of the quadrant electrometer (p. 107) does not seem likely to convey any clear idea of the construction of the instrument.

The subject of the testing and laying of submarine and land telegraphs is not very fully treated, and the data in this department is also comparatively meagre. On the other hand, descriptions of a large number of dynamo-machines and statements of experimental results regarding their behaviour in electric lighting and transmission of power form a marked feature of the book, and we need not say that even roughly approximate information of this kind in a collected form is very valuable.

On the whole, we feel sure that the work will form a valuable pocket companion to the electrical engineer.

A. GRAY

Science Note-Book. By C. H. Hinton. (London: John Haddon and Co., 1884.)

THE constitutive elements of Euclidean geometry are the straight line and the circle—two continuous curves, which stand to one another in a certain relation of reciprocity, and the actual production of which, as Newton has already remarked, demands certain mechanical appliances—the ruler and the compass. If we add to the above that Euclid's method is the synthetical, then his system of geometry is defined without ambiguity. The principal lack of this geometry, which was not clearly brought to light until the second half of this century, consists in this, that it is limited to considerations of quantity, and only treats secondarily of the relations of position.

Poncelet has recognised this defect, and has laid the foundations of the so-called modern geometry, which, during the last few decades has so greatly enriched the science of space as well in positive results as in new methods.

Euclid's system, however, has not been uprooted, but only completed on a side on which it was wanting. In schools the "Elements" of the Alexandrian geometer are generally taught, while descriptive geometry and the theory of higher curves (as taught in the University course) are chiefly based on modern methods.

In a handy introductory publication Mr. C. H. Hinton, Science Master at Uppingham School, has brought forward points of view which form a third method of geometrical investigation, fundamentally different from both those mentioned above. It is not opposed to either, but appears as a welcome complement of both. The author does not presuppose continuous elements as has been generally done, but only sets of points equally distributed in two dimensions, which, merely for the sake of convenience, are connected by straight lines. As in Euclid's geometry an infinite pencil of rays can be drawn from every point, so the conic sections may be determined by a method of counting discrete points. The problem of division of a given line into parts, and of the construction of parallels can be generally solved.

The practical advantages of this new method in the form in which it is now published are purely educational, though it is wholly based on the principles just mentioned. The author has succeeded in bringing new ideas into simple and attractive form, which enables the youthful and inexperienced mind in a very short time to acquire a mathematical knowledge of space which is of much value in facilitating a subsequent thorough understanding of Euclid and of modern geometry. The work has an encouraging appearance, inasmuch as it does not contain any hypercritical transformation of the system of our old Euclid (in which respect so many authors have recently

erred), but makes us acquainted with new thoughts which in themselves are worthy of pursuit, and which in their present form are of general educational service.

KARL HEUN

The Dynamo: How Made and How Used. A Book for Amateurs. By S. R. Bottone. (London: W. Swan Sonnenschein and Co., 1884.)

THIS little book of 75 pages is designed to give to amateurs practical information as to the construction of a small working dynamo-machine. What is aimed at is the building up of a machine capable of being worked by hand and suitable for experimental purposes. The dynamo-electric machine is one which an amateur mechanician may very well undertake with every prospect of success and satisfaction; and the book before us is thoroughly practical and is pleasantly written, and will, we feel sure, be acceptable to many. We are acquainted with books on the steam-engine for amateur constructors; but a dynamo of simple form is easier to make than a steam-engine, and will, we think, when made, prove a far more useful and pleasure-giving toy than a steam-engine such as an amateur can put together. When all is done, a steam-engine of amateur construction can do little more than go round and round; but a host of experiments in electric lighting and in electro-chemistry may be made to follow on the successful completion of a small hand-dynamo.

The author describes the making of a very simple dynamo with a kind of shuttle-wound armature. All his instructions are clear and, as we have already said, thoroughly practical. The only question on which we have any doubt whatever is whether, at any moderate speed of turning, the dynamo will yield so much current as the reader is told he may expect.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Natural Science in Schools

As one who has been engaged in teaching science in schools for the last ten years, I should like to make some remarks on Prof. H. E. Armstrong's interesting lecture, published in NATURE of November 6 (p. 19).

(1) In the first place I would like to express my agreement with his weighty opening words. The main body of schoolmasters are so completely without any science-training that it is very difficult for many of them to see its necessity or even its advantage. The younger generation of masters in the large public schools, moreover, having come to the work in recent years have not, like their predecessors at Rugby, Clifton, Taunton, and elsewhere, had an opportunity of observing the gain of life and general intelligence which followed the introduction of science into the regular school work, in those schools where it was taken in hand seriously and with enthusiasm. Others, again, have more or less forgotten. Consequently it is still necessary to point out that, excellent as is the training given by the mathematical and classical teaching of our schools, yet that by itself it is not enough. No excellence in the *method* of teaching classics and mathematics will compensate for this, to adopt Dr. Armstrong's words, that they fail to develop "the faculty of observing, and reasoning from observation and experiment," that they fail to give any idea in the concrete of the nature of evidence. No doubt many able men educated on a classical or mathematical basis, can observe and reason from observation; this is, however, in spite of, and not in consequence of, their training. To the majority the deficiency is a serious matter, and probably it goes far to account for the peculiar opinions of scholars one sometimes hears expressed by practically successful men, and produces the unfortunately too prevalent idea among them that, if their sons are to go into business and to succeed, they must not stay at school too long—they must not learn too much book-learning. It should, then, in addition to its other services, be the function of science in education to keep awake and develop the natural practical intelligence of our lads, and so to make up for the deficiencies in this respect which accompany the otherwise vast advantages of a literary and mathematical culture.

(2) I suppose that no science-teacher will fail to agree with Prof. Armstrong that we have by no means exhausted the possibilities even of our present opportunities. As my object is to advocate advances, however, I will not dwell upon that part of his remarks except to say that I am sure a closer acquaintance with the methods of a good many of our science schoolmasters—with the time at their disposal, the laboratories they work in, and their boys, in short with the conditions under which they work—would satisfy him of the considerable value educationally, when it is properly done, of much that he condemns, and also that something of what he advises is already being attempted.

The lectures in schools are already, I should say, usually more or less of the nature of the tutorial classes which he recommends, and, whilst we recognise a great educational value in analytical work, if properly taught, we shall, I feel sure, be ready to abandon that for something better as soon as it is ready for us.

Having said this much, I hasten to add that I quite recognise, on the other hand, the value of Prof. Armstrong's suggestions, and that I am at present conducting a class on a system which in principle is very like that which he suggests. Indeed it is in several important points the result of suggestions made to me by Prof. Armstrong some two years since. More particularly I am trying a form of what I may call the problem method of practical teaching, which Prof. Armstrong so strongly recommends.

As it is only lately that we have had the necessary accommodation for this attempt, my experience is not very great. But I have learnt a good deal, and, as Dr. Armstrong's lecture brings the question into prominence just now, I may say what my experience is so far. Remembering that economy of time is of the first importance, and that our object in teaching science in schools is to promote a certain attitude of mind towards Nature rather than to produce skilful manipulators, I am not yet certain whether courses of work in which each pupil, with assistance, suggests and carries out the experiments himself, or tutorial classes, in which the suggestions are as far as possible elicited by the teacher from the class, and then the work is carried out by the teacher before the class, will give the best results. I tried the latter plan some years ago with beginners at Taunton with the most encouraging results. I believe, however, that a combination of the two methods will finally prove best. There is no doubt that greater interest is created when the pupils do the work themselves; on the other hand, much time is lost, at first, through difficulties of manipulation. Accordingly I am trying to arrange things so that the simpler experiments shall come together and be done by the boys; and when anything more difficult has to be done we fall back upon the tutorial method. I have no doubt of the advantage of practical work combined with some form of lecturing, *if there is time enough.* But in schools there rarely is time enough given for both. As an introduction to a course of lessons on the present system a practical course or a tutorial class on the lines proposed by Dr. Armstrong will certainly be of great value, and one or the other must, I think, be possible in almost every school.

(3) I will now pass to some points not discussed by Dr. Armstrong in which it appears to me that chemical teaching at present is open to improvement. I always aim, myself, not at informing my classes of chemical facts or principles, but, as far as possible, at leading them to discover them for themselves. In this I am more or less hampered by the absence of sufficient appreciation of the bearing of the simpler physical facts of Nature upon chemical processes. This I supply as far as I can. But I believe, and I am trying the experiment, that a real advance in the value of chemistry as an education will be made if, as an introduction, the beginners are put through a course of practical problem work which brings out in every possible way the dependence of chemical operations upon the simpler physical properties of matter; such as volatility, solubility, &c.

(4) I was told the other day, by a great authority on educational matters, that science has had a distinct and good effect on grammar-teaching. I think, on the other hand, that science-teachers have been rather slow to recognise and imitate one

particular excellence in the method of language-teachers. I refer to the practice of making the students acquainted with the works of great writers at the earliest possible period. I should like to see fairly advanced classes of chemical and other students, in schools and elsewhere, reading, with assistance, some of the more suitable memoirs of such men as Davy, Graham, and Faraday. I do not advocate the complete abandonment of text-books, but I should rejoice greatly if their use could be considerably restricted and something better substituted. Has not this neglect of the original writings of great workers by our teachers something to do with the subsequent neglect of research by so many of their pupils? There is of course this practical difficulty in the way of what I propose—that original memoirs are not at present obtainable in a form in which they can be put in the hands of whole classes of students. If my suggestion should prove acceptable to even a few teachers however, that is a difficulty which could be very easily surmounted.

(5) When any one proposes to himself a change in his mode of teaching, unless his position is quite exceptional, he always finds himself confronted by one solid difficulty, viz. public examinations of one kind or another. Teachers at first inspired the examiners. Now they find themselves too often helpless before them. In the face of our various examining Boards individuals are nearly powerless. The time seems to have come when an association of science-teachers for the improvement of science-teaching is a real necessity—something more or less resembling the Association for the Improvement of Geometrical Teaching. Such a body would often be invaluable. It could, by the appointment of committees, and perhaps by pecuniary help, promote such experiments as I have suggested in Paragraph (4). In cases such as the recent unfortunate action of the War Office, it might be expected to do good work by replacing individual by organised action. And it could hardly fail, by bringing teachers and examiners into contact, to do much to make advances in teaching more possible than at present.

My various remarks on so many points have necessarily been brief and incomplete. I could not, in the form of a letter, go *fully* into questions of advantage, disadvantage, and difficulty. I shall have amply attained the object I have had in view if I have helped to draw attention to these important matters.

W. A. SHENSTONE

Do Flying-Fish Fly or Not?

I HAVE crossed the Atlantic and Indian Oceans many times and at different seasons of the year, but until my last voyage to Calcutta I was unable to answer this question positively. For days together, aided at times by a powerful field-glass, I have endeavoured to establish satisfactorily whether these nimble little fish used their membranous wings after rising above the surface of the sea or not. An old and valued friend, the late Charles Kingsley, on his voyage to the West Indies, so graphically painted in the pages of "At Last," records his opinion in favour of the wings being employed as a means of propulsion through the air after the fish quit their more natural element, and I certainly inclined to the same belief, although, owing to the "ever-vexed" condition of the Atlantic, I found accurate observation impossible. In the Indian seas the fish appear at rarer intervals, and limit correspondingly the chances of watching their movements.

On a blazing afternoon in May last, on board the steamer *India*, some hundred miles off the African coast on the way to Ceylon, I had the first and only opportunity I ever enjoyed of establishing beyond dispute this vexed question, which I am not aware has hitherto been settled. The sea was perfectly calm, covered here and there with a yellow scum which exhaled a fresh unpleasant smell like a beach covered with sea-weed at low water. From the spar-deck above the cabins, which were fitted up in the fore-part of the ship, I could descry at frequent intervals shoals of flying-fish rising and apparently fluttering from 50 to 100 yards before dipping again into the mirror-like surface of the ocean. Along with several of the passengers—some of them provided with field-glasses—I vainly endeavoured to make certain whether the fish did or did not make use of their wings after leaving the water. Opinions were divided, for, owing to the rapid motion of the fish, it was impossible to keep any one of them long enough in the field of vision. It occurred to some of us at length to look over the bows of the steamer, and there we saw a sight not soon to be forgotten. The flying-fish appeared frequently shooting upwards in large numbers from the blue glassy depths directly beneath us, as the shoals were disturbed by the vessel's cutwater, and their every movement plainly discernible while under water and from the moment they rose "winnowing the waving element" with expanded wings and tail, bent on escaping the pursuing craft, until they dipped again into the sea for shelter or to obtain fresh impetus for continued flight. I satisfied myself, and so did my fellow-watchers, that after a certain number of strokes with wings and tail—from twenty to thirty, varying with the dimensions of the fish—which we repeatedly counted, as they left corresponding impressions on the oily surface of the water, these appendages were not employed to accelerate, but merely to sustain, the flight while the fish remained in the air. The curved impressions left by the wings on the water appeared, as nearly as I could judge, from twelve to eighteen inches apart on either side of the fishes' course until clear of the water. The tail left no perceptible imprint, but could be clearly seen waving from side to side, adding doubtless considerably to the impulse. After rising out of the water the wings and tail remained ridged, but in some instances were slightly twisted to preserve the equilibrium. Occasionally a fish appeared to lose its balance in the hurry of escape, and toppled over in a ridiculous fashion.

The yellow scum also attracted attention, tinging the ripple at the bows a deep orange. I had some of it brought on board, and a fellow-passenger of an entomological turn placed some under a powerful microscope, but failed to determine the species to which it belonged. Ten years ago, near the same place, I observed the water assume a dirty yellow tinge, as though it had suddenly shoaled, while the same unpleasant smell was perceptible. The discoloration and smell I found to be due to the presence of vast quantities of animalcula, about a quarter of an inch long, semi-transparent, jointed like a cane, and about the thickness of a small needle.

ROBERT W. S. MITCHELL

8, Garden Reach, Calcutta

Earthquake Measurements

I REGRET that Prof. Ewing should take so much to heart my criticisms of his results of earthquake registration. I think that if we can get a single movement instead of a double one we gain much by halving the errors of double registration, extra friction, complexity of calculation, &c., all causes that tend to increase the imperfection of the results.

Neither did I intend to disparage seismological investigations on the plain of Yedo, but it does seem to me that the first thorough study, such as Prof. Ewing and others have initiated, should be in a locality where the minimum of disturbing influences would be able to complicate the results. In fact, we should expect much more progress in arithmetic in a child which commences by learning to count than in another that is immediately put to study fractions. I should never suggest that one earth-shaken locality should be continuously studied more than another when once we have decided upon the most serviceable and accurate registering apparatus.

Now as a resident in a country continuously shaken by earthquakes, many of which are disastrous, and where investigators are few and far between, we want instruments that give the least complicated tracings possible if we are to find observers amongst inhabitants of the Italian provincial towns. The same thing holds good to a variable extent in other countries.

Again, hardly any one would accuse me of claiming entire originality for the principle in the apparatus described. For example, every one knows that the pendulum has been used as a seismograph for centuries even. All that I claim is a combination of different forms of actuating and registering apparatus, with a few novel introductions, for it is practically impossible to *invent*, in the true sense of the word, a new seismograph any more than a new locomotive.

Perhaps, in my critic's opinion, we have reached perfection in seismographic instruments, which it appears is not shared by many workers, as the continual new suggestions and modifications indicate, as does also the fact that throughout all the observing-stations so far instituted it is rare to find two provided with similar instruments.

In regard to Prof. Ewing's last paragraph, perhaps experience will determine whether my suggestions do really lie outside the sphere of practical seismology.

In conclusion I shall be happy to hear suggestions for any improvements from others, for in my own humble opinion we do not yet possess a single seismograph that reaches near to perfec-

tion (my own of course included), so that we may still consider the instrumental investigation of earthquakes far from a settled matter, and one to be more fully worked out.

Naples, November 10 H. J. JOHNSTON-LAVIS

Autumn Flowering

REFERRING to your article on autumn flowering (p. 13), I may mention that my garden primroses are now flowering again, and a laburnum is in flower in the garden of one of the houses on this road. I was in Paris in September 1861, and saw many horse-chestnuts in flower. The summer of 1861 was unusually warm and dry on the Continent, though I believe not in the British Islands. JOSEPH JOHN MURPHY

2, Osborne Park, Belfast, November 14

The Northernmost Extremity of Europe

"A NORWEGIAN" (NATURE, p. 17) says that my description of Knivskjærodden as a low glaciated tongue of rock is hardly correct. As Norwegians ought to, and generally do, know more about their own land than do foreigners, I will quote Tönsberg, whose "Norge" is admitted as a high authority by all. Describing the scene displayed from the edge of the precipice of the North Cape, he says: "Beneath you at a distance of one-eighth of a mile, you see the *long low* Knivskjælodde, *which is undeniably the most northern part of Norway.*" The picture in his book (from a photograph) shows the northward extremity of this projection as washed over by the waves and its *western side* precipitous, as I saw it.

I sailed round it twice, more than ten years ago, halting in front of the North Cape for half an hour, and can only smile at the attempt to claim the northward supremacy of Knivskjærodden as a new discovery or one demanding further verification. In my copy of Munch's map (1852) it is shown as projecting a little further north than the North Cape.

Tönsberg further confirms my statement concerning the elevation of the neighbouring Arctic headlands, which "A Norwegian" also contradicts. Sverholtklubben, according to Tönsberg, is twenty-four Norsk feet higher than the North Cape. I should have added that the measurement I gave was in Norsk feet. Measured in English feet, the height of the North Cape is 1004 feet; that of Sverholtklubben 1029 feet at the edge of the cliff. There are about a dozen other headlands of similar magnitude between North Cape and the Varangerfjord.

W. MATTIEU WILLIAMS

Breeding of the Quadrumana

HAVE any of your readers any experience of the production in captivity, of a *second* generation of any of the quadrumana? At least twelve out of about eighty species kept in the Zoological Gardens have bred during the past thirty years—the lemurs forming a large proportion—and the Rhesus more frequently than any other monkey. I presume that even a *first* generation of any of the anthropoids is unknown—except possibly of the gibbon (?). The disposition and moral character (in the widest sense) of no species of monkey whatever approaches that of the dog. May not this be due to the absence of inheritance (to which the dog owes so much) of the gradually accumulated cultivation of these qualities through association with man? The dog has enjoyed all these advantages. The monkey cannot, owing to the impossibility of rearing a succession of generations in captivity. Does the experience of your readers, who may have studied a first generation of monkeys, point to any improvement on the parent stock in dis osition and character? So far as I have been able to judge from individuals in public collections, the mere mental power of these animals conspicuously exceeds that of any others. I should be glad to know whether this opinion is shared by those who have had more extended opportunities of observation. ARTHUR NICOLS

Fly-Maggots Feeding on Caterpillars

YOUR correspondent, Dr. E. Bonavia (p. 29), is mistaken in supposing the flies bred from his butterfly-chrysalis were "house-flies." They belong to the sub-family *Tachininæ*, which is of very large extent, comprising several hundreds of species in Europe alone, and all probably parasitic in other insects. The "house-fly" belongs to the sub-family *Muscinæ*. The mistake is very pardonable, for there is often great external similarity in form, colour, and size, and it is one frequently made in this country. R. MCLACHLAN

Clarendon Road, Lewisham, S.E., November 14

IT might interest Dr. E. Bonavia (November 13, p. 29) to know that it is not an unusual circumstance to find the larvæ of the house-fly in the nests of *Vespa vulgaris* and *V. germanica* feeding upon the live bodies of the larvæ and pupæ of the wasps. Occasionally I have found nests in the summer-time quite deserted by the wasps, all the pupæ in the cells having been eaten by the maggots of house-flies and other *Diptera*. F. W. ELLIOTT

Buckhurst Hill, Essex, November 18

The Sunday Question

THE announcement that, "after opening the Free Library on Sundays for two months, the Town Council have resolved to close it again *in consequence of the small number of visitors*," seems to indicate that the Town Council of Chester were as wise in deciding to close the Library as they had previously been in giving the people of Chester an opportunity of spending a portion of their day of rest in the Public Library, where those who do not possess libraries of their own can obtain access to the wisdom of the ages as stored in books.

If the facts are as stated, no one can complain of the action of the Chester Town Council, though some would have been glad to have seen a little more patience with people who for so long have been compelled to spend their Sundays when not at home either in the church, the public-house, or the streets, all of which may be attended with advantage and profit by free and intelligent men and women; but when men are driven to either of these places, what should be a blessing becomes in too many cases a curse.

However, as I have said, we have no right to complain of the Town Council of Chester closing the Public Library on Sunday if there is no considerable number of the people of the town desirous of using the institution on that day. In civilised communities representative authorities such as town councils and parliaments are only justified in spending public money on institutions when at least a considerable section of the community desires it.

The Sunday Society bases its claim for the Sunday opening of the British Museum, the South Kensington Museum, the Natural History Museum, the National Gallery, and the Bethnal Green Museum on the ascertained fact that very large sections of the community do desire to visit them on Sundays, and if it be replied that there are more people who have no such desire and therefore these institutions should be closed, I answer that that argument would close the whole of them on every day in the week, for no one will for a moment contend that a majority of the people of the United Kingdom have visited, or can possibly visit, these national exhibitions of the wonders of the universe and what we call its highest product—man.

But the benefit of these institutions is not confined to those who actually visit them. The sermon of the Puritan divine and the lecture at the mechanic's institute are alike indebted to the British Museum and the other institutions named.

Let the trustees of the British Museum follow the example of the Town Council of Chester and open the Museum on Sundays for two months, and the question, so far as the Sunday Society is concerned, will be settled for ever. I will venture to say that after such an experiment the British Museum would never again be closed on Sundays, and with such an example in the centre of the metropolis, no Sunday Society would be longer needed to advocate the opening of museums, art galleries, libraries, and gardens on Sundays.

The statement that at Keswick the "Sunday-opening experiment had been tried and abandoned" is true, but it should be explained that the Library at Keswick is not a public institution in the sense of being supported by rates and taxes, and is under the sole control of the vicar of the parish. It was the late vicar who closed the Library on Sundays, and I have the pleasure of announcing the fact that the Sunday-closing experiment has been tried and abandoned. The present vicar, the Rev. J. N. Hoare, did not decide to do this on his own authority, but he convened a special meeting of the Committee to consider the question,

when it was decided to again open the Library, during the winter season, on Sundays. MARK H. JUDGE,

Honorary Secretary of the Sunday Society

8, Park Place Villas, Paddington, W., November 17

A Pugnacious Frog

A SHORT time back, about 6 o'clock in the evening, just as it was getting dark, hearing a squeaking noise below my veranda, I got up to look, and saw a most amusing sight, viz. a fight between a frog and a bat. The latter was evidently getting the worst of it, but at last suceeeded in getting away for a time from its opponent; the frog again attacked it, but this time *he* was glad to cry "quits," as the bat turned on him and beat him off, afterwards managing to hide somewhere so that we could not find it; the frog, however, was sorely bitten about the nose, and was in a sad plight. I do not know how the bat could have been on the ground, but it had probably fallen from its nest during the day, and was waiting for the evening, when the frog espied and attacked it with the bef re-mentioned result.

EDWIN H. EVANS

Margapala, Soemedang, Java, October 13

A DISEASE-GERM MYTH

WE are indebted to a correspondent for the following curious note from Fiji:—

You may have seen Wilfred Powell's "Wanderings in a Wild Country; or, Three Years among the Cannibals of New Britain." If you have not seen it, pray send for it, for, though falling far short of what it ought to be, it is not without interest. At p. 167 he tells a story of native magic which reminds me of something I have read before.

A native doctor being called in to a patient "looking wretchedly ill," performs a little "devil-devil" business, and then blows some burnt lime from the hollow of his hand against the patient's stomach; "then he began to scratch the man's navel with one finger," gradually approaching his mouth to the fellow's stomach, and drawing in his breath. Presently he places his mouth close to the man's navel, draws back suddenly, retches violently, and——throws up a worm. This the worthy doctor does twice.

Powell says, "I looked at the worms, they were *unlike anything I had seen before*, and appeared as if they certainly might have come from a man's body."

Now see Bates on the Amazons, cap. ix.:—"This (the illness) the Pagá pretends to extract, he blows on the seat of pain the smoke from a large cigar, . . and then sucks the place, drawing from his mouth, when he has finished, what he pretends to be a worm. . . . Senhor John contrived to get possession of the supposed worm after the trick was performed in our presence, and it turned out to be a *long white air root* of some plant"!!

Wilfred Powell should have got that worm or another specimen, even if he had been compelled, in the interests of science, to explore the patient's stomach with a pickaxe.

When Macdonald, of the old surveying-ship *Herald*, was in these waters, he was daily searching for a specimen of the pearly Nautilus (*N. pompilius*), which is pretty common here. One day upon the reef at Nasamusovu he met a Fijian coming out of his canoe in which he had been fishing. He showed him the picture of a Nautilus, which the man recognised at once, and, in reply to a question put through an interpreter, said he had just eaten one. Macdonald got into a great rage at the loss of such a treasure, but suddenly checking his excitement and glancing rapidly over the native, he said to the interpreter, "Quick, ask him how long it is since he ate it."

But there was something in the eye and the tone of the doctor's voice that so startled the gentle child of Nature that, before the interpreter could open his mouth, he had taken to his heels and put half a mile of reef between himself and the man of science.

What awful thought passed through Macdonald's mind has not been left on record.

THE BUDDHIST THEORY OF EVOLUTION

THE theory of evolution held by adepts in Buddhism is the outcome of the researches of an immense succession of investigators, believed to be qualified for their task by the possession of spiritual faculties and perceptions of a higher order than those belonging to ordinary humanity. In the course of ages the block of knowledge thus accumulated concerning the origin of the world and of man and the ultimate destinies of our race, checked and examined at every point, verified in all directions, and constantly under examination throughout, has come to be looked on as the absolute truth concerning the evolution, past and to come, of man and the planets he is destined to inhabit. The initiated members or "adepts" of the Buddhist cult claim to have attained, through intense self-absorption, a knowledge of physical laws of Nature not yet understood by Western science, investing them with extraordinary powers known as spiritualistic, such as clairvoyance and the disintegration and reconstruction of matter by a simple effort of will. They claim in fact to be in possession of potential faculties which will only be generally developed in future stages of evolution. This religion, which is wholly unaggressive and seeks no converts, attracts many on account of its claims to be in accord with all established scientific fact, and by its incorporation of so patent a truth as the doctrine of evolution as an integral part of its system.

A brief examination of these claims, and a glance at the past and future of man's evolution as thus elaborated, can hardly fail to be of interest, if it fails to carry conviction.

It is impossible, and unnecessary, to attempt to follow briefly the mystic subtleties of belief that have fascinated the Oriental mind, and been to it for ages what the pursuit of practical science has been to Western nations. Shortly stated, the Buddhist divides the human entity into seven principles, the higher of which have not yet reached their full development. The first three are of the earth, and done with at death. These are (1) the body; (2) vitality, or the life principle, an indestructible force which attaches itself to other objects after the decomposition of the body; (3) the astral body, "an ethereal duplicate of the physical body," which can under certain circumstances become disembodied and visible as a ghost; (4) the animal soul, or seat of all animal desires; (5) the human soul. The other two can be passed over, as they are still in embryo, and belong to a wholly superior and future condition of existence. The fifth and, later on, the sixth principles make up a man's continuous individuality through successive incarnations.

The solar system consists of seven planetary chains. The one with which man is concerned consists of seven planets, through each of which he has to pass seven times in order to accomplish his evolution. These are the Earth, Mars, which is in a state of entire obscuration or rest as regards the human life-wave, Mercury, just beginning to prepare for its next human period, and four other planets which are composed of an order of matter too ethereal for telescopes to take cognisance of. The system of worlds is compared to a system of towers standing on a plain, each of many stories, man's progress being a spiral round and round the series, passing through each tower as it again comes round to it, at a higher spiritual level than before. The impulse to the new evolution of higher forms is given by rushes, not a continual flow, of spiritual monads coming round the cycle in a state fit for the inhabitation of new forms, and those which for milleniums have gone on merel

repeating themselves then start afresh into growth, and rise rapidly, through intermediate, to the higher forms. The spiral character of the progress, and the fact that the tide of life passes from planet to planet in gushes, accounts for the gaps in the various kingdoms of Nature. Each time a spiritual monad arrives on a planet it has a complicated process of evolution to perform. It is many times incarnated before it passes onward, and man has many incarnations in each great race, the normal sum being not far short of 800, with an interval of at least 1500 years between each, spent in the "world of effects, or heaven of ordinary theology." In the first planetary round man inhabited an immense but loosely organised body, and could not be called intellectual. In the second he becomes of firmer body, whilst in the third he is rather in form of a giant ape than true man, yet of concrete body and advanced intelligence. In the fourth, the present round, his intellect becomes fully developed, and he achieves enormous progress. We now approach the transcendental mystery of mysteries, our future development. The fifth round will be occupied with a struggle between physical intellect and spirituality. In the sixth round a state of perfection of body and soul will be attained which can hardly even be imagined; while as to the seventh round the occult teachers themselves are solemnly silent, it being altogether too God-like for realisation. At the end of each planetary round an intercyclic period of extraordinary exaltation must be undergone. It is by processes of occult training that adepts project themselves precociously into the fifth round, or possess themselves of the attributes of fifth-round men, so as to be able to explore the mysteries of Nature and of other states of existence, and to assimilate knowledge by clairvoyance independently of observation.

We now exist in the fifth race of the fourth round. The first and second races developed no civilisation, but the third and fourth did do so several millions of years ago, though no traces of such now exist. The periods of the great root races are divided by vast convulsions or geological changes, which cut them off at the appointed time, leaving only a few survivors behind, who rapidly relapse into barbarism. The fourth race lived on "Atlantis," and reached its apogee in "the Eocene Age," when this great continent showed the first symptoms of sinking, a process that occupied it down to 11,446 years ago, when its last island, Poseidonis, went down with a crash. "Lemuria" was drowned with its high civilisation and gods about 700,000 years earlier than Atlantis, or just before the early part of the Eocene Age, the relics of its third-race inhabitants existing in some of the flat-headed aborigines of Australia. The true Chinaman is interesting as a relic of the fourth race. The civilisations of the ante-Glacial period were superior to those of Greece and Rome, or the Egyptian, which was in its decadence 12,000 years ago. The uninhabited Arctic regions will prove not only to have enjoyed a tropical climate, but were likewise the seat of one of the most ancient civilisations of the fourth race. Atlantis belonged to the Miocene times, and the cataclysm which destroyed it came at the appointed time, "otherwise it would be impossible for the best seer to calculate the exact hour and year when such cataclysms great and small have to occur." The relics of these former civilisations are hidden in strata which have never been geologically explored, deep in the unfathomed ocean beds.

An important part of the Buddhist creed is the belief in the alternation of periods of repose with periods of activity. As man sleeps every twenty-four hours, and vegetation subsides and revives with the seasons, so rest periods follow each incarnation. The tide-wave of humanity flows on to each of the seven planets seven times, and passes through its seven races and ebbs away again, but the great rest period of our planetary chain does not begin until the seventh round of humanity is perfected. At an incalculably remote period the whole of the seven planetary chains of our solar system will pass into a period of rest, and finally the whole universe itself will have its great cosmic night. After the long night of a planetary chain the animal and vegetable world resume their arrested activity, but when the time arrives for all the planetary chains of our system to pass into their night, each planet, as the seventh-round man quits it, is annihilated instead of merely becoming invisible, and there is an outflow from every kingdom of its entities. These will rest in lethargic sleep in space until brought into life again at the next solar period, and will then form the soul of the future globe. We have every indication that at this very moment such a solar night is taking place, while there are two minor ones ending somewhere. At the beginning of the next solar day period the hitherto subjective elements of the material worlds, now scattered in cosmic dust, will form into primordial ripples of life, and, separating into differentiating centres of activity, combine in a graduated scale of seven stages of evolution. Every orb will pass through seven stages of density, until its solidification and desiccation at last reach a point when it becomes a relaxed conglomerate, and its constituent masses cease to obey the laws of cohesion which hold them together.

Evolution takes its rise in the atomic polarity which motion engenders. In cosmogony the active and passive forces correspond to the male and female principles. The attribute of the universal spiritual principle is to expand and shed, of the material principle to gather and fecundate. These become consciousness and life when brought together. Our planet, like an iceberg, is merely a state of being for a given time, and its present appearance, geological and anthropological, is but transitory and will pass away.

Such are the beliefs and doctrines concerning evolution [1] held by the Oriental scholar, who holds in pity the benighted ignorance of Western so-called science. The book from which they are gathered is sober earnest, and I am asked whether the Buddhist ideas on evolution are in accord with the discoveries of science. The mere statement of the belief, shorn of its mysticism, is a sufficient answer. The importance attached to the numeral 7 seems puerile, and its reason is not easy to discover; it is claimed that the colours of the spectrum and the notes of the musical scale are seven, and that there are seven kingdoms in Nature. There is one seeming scientific fact, however, which, though it has escaped the "adepts," favours so far the belief in evolution by gushes, and is still unexplained. The first appearance of many forms of life on our planet, it is well known, is very sudden. All the groups of Mollusca, and especially in the case of Ammonites, appear at once fully developed and in great variety of species, and never develop into anything higher. So with the Echinodermata, the Crustacea, Insecta, the different orders of fishes, many orders of reptiles, marsupials, ferns, and dicotyledons. All these seem to have been evolutionised in a very sudden manner, and as yet afford no grounds for controverting the Buddhist belief that they are well developed arrivals from other planets.

J. STARKIE GARDNER

THE RAINFALL OF 1884

THE water famine with which the towns of Manchester and Bradford have recently been threatened has served to draw public attention to the fact that the rainfall of the present year has been strikingly deficient. As the extent of the deficiency is, however, little, or at the best imperfectly realised, a few reliable statistics on the subject may be of more than ordinary interest.

The following table shows, for seventeen places situated

[1] Condensed from Mr. A. P. Sinnett's book, "Esoteric Buddhism" (Trübner and Co.), and as far as possible in his own words.

in various parts of the United Kingdom, the excess or deficit of rain which has occurred during the first, second, and third quarters of the present year, and also similar values for the month of October. In the last column we have the number of months in which the rainfall has been less than the average. It must, however, be explained that these numbers do not necessarily signify consecutive months. The values in the table have been compiled from the Monthly and Weekly Weather Reports issued by the Meteorological Office, and the averages employed have been those for the fifteen years 1866 to 1880.

Recording stations	Excess or deficit					No. of months with deficiency of rain
	January to March	April to June	July to September	October	The whole ten months	
England and Wales	per cent.	per cent.	per cent.	per cent.	per cent.	
York	+33	−54	−18	−70	−22	6
Stonyhurst	+31	−46	−21	−29	−13	7
Blackpool	+41	−32	−14	−45	− 2	6
Manchester (Prestwich)	+18	−44	− 8	−43	−14	8
Llandudno	+30	−32	−23	−66	−17	6
Leicester	−13	−27	−33	−39	−27	8
Hereford	+ 4	−19	−29	−70	−23	6
Cirencester	−11	−22	−29	−68	−26	6
Marlborough	+ 7	− 9	−37	−69	−21	6
Oxford	−20	−24	−41	−69	−34	10
London	−28	−37	−39	−62	−38	10
Cambridge	−30	−28	−10	−38	−23	9
Scotland						
Aberdeen	+22	−36	−30	− 8	−11	7
Leith	+16	−30	+ 9	−40	− 5	6
Glasgow	+21	−34	+ 3	−17	− 2	6
Ireland						
Londonderry	+37	−16	−11	+ 5	+ 4	5
Dublin	+20	−33	−46	−78	−29	8

An examination of the first column shows that during the first quarter of the year there was a deficiency of rain over the midland and south-eastern counties of England, but an excess in all other parts of the kingdom. The deficiency was most clearly marked in London and its immediate neighbourhood, where the total fall was from 28 to 30 per cent. less than the average. The excess was greatest in the north-west of England and north of Ireland; in most parts of these districts the aggregate was from 30 to 40 per cent. more than the average, but at Blackpool it was as much as 41 per cent. more.

The figures in the next column show that during the second quarter of the year the weather became much drier, and in fact a deficiency of rain was recorded over the entire kingdom. With the exception of Marlborough, where the falling off amounted to only 9 per cent., and Hereford and Londonderry, where it was respectively 19 and 16 per cent., the deficiency varied between 22 and 54 per cent., the lower value being recorded at Cirencester and the higher at York. Upon the whole it appears that the driest weather was experienced in Scotland, the north and north-west of England, and the neighbourhood of London.

From the figures in the third column it would appear that a very similar state of affairs prevailed in the July to September quarter. With the exception of Leith and Glasgow, where there was a trifling excess, every station in the table again had a deficiency of rain, the districts more seriously affected being the western and southern parts of England and the east of Ireland. In the catchment basin, from which the northern towns derive their water-supply, the deficit was not so strongly marked as in other parts of the kingdom, and the serious state of affairs which prevailed during October must therefore be set down to a long continued rather than an exceptionally severe spell of dry weather.

The figures for the month of October, given in the fourth column, show that the fall of rain was then abnormally small. At Londonderry, it is true, there was a slight excess, and at Aberdeen the deficit was not particularly striking, but in other parts of the country the falling off was very considerable. At many of the English stations the total for the month was only one-third of the average, while at Dublin it did not amount to as much as one-fourth. The places least affected were Stonyhurst, Leicester, and Cambridge, where the amount was from 29 to 39 per cent. less than the average.

The general result of all these facts, as given in the fifth column, shows that, with the exception of Londonderry, the rainfall of the past ten months has been less than the average in all parts of the kingdom. At Blackpool, Leith, and Glasgow the deficiency has not been particularly remarkable, but elsewhere, and especially in London and the home counties generally, it has been very great. At Oxford, and also in London, the aggregate fall for the period has been only about two-thirds of the average; and there is consequently no reason to doubt that, unless the weather of the remaining few weeks of 1884 undergoes a very sudden and decided change, the total for the year will be unusually small. Up to the present time (November 18) the rainfall for November has only amounted to one-third of the average for the whole month.

The last column in the table gives the number of months during which the amount of rain has been in defect of the average. At Manchester, Leicester, and Dublin there have been eight such periods, and at Cambridge nine; while at Oxford, and also in London, every month has shown a deficiency.

In endeavouring to compare the above figures with those for previous years, the meteorologist is met at the outset by a very familiar difficulty, namely that of finding reliable information for any very long period. As regards London, however, some valuable statistics are to hand in the rainfall diagram prepared some years ago by Mr. George Dines, F.R.Met.Soc. This diagram, which gives the monthly and annual fall of rain in the London district during the sixty years 1813 to 1872, was compiled with great care and precision partly from Luke Howard's observations, partly from the Cobham journals, and to a large extent from information published or supplied by Mr. Symons. By completing the statistics up to the present time, we get a long and very valuable series of returns, and are also able to obtain a really good and reliable average. In the following table are shown the

Years	For the whole year		January to October		No. of months in year with deficiency of rain
	Total fall	Percentage value below average	Total fall	Percentage value below average	
	inches		inches		
1832	19·8	20	16·4	24	9
1837	19·4	22	16·5	24	9
1840	19·4	22	15·5	28	8
1847	17·7	29	13·5	37	11
1850	19·2	23	15·8	27	9
1854	18·7	25	15·3	29	11
1858	17·3	30	15·2	30	8
1864	17·4	30	14·5	33	9
1884	—	—	13·4	38	?

total amounts of rain in London during some of the driest of the past seventy-one years, together with the percentage difference from an average based on the seventy years'

observations 1813 to 1882. In selecting the years, those only have been chosen in which the aggregate fall of rain has been at least 20 per cent. less than the average. The table further gives the total fall and difference from the average for the first ten months in each of these years, and in the last column will be found the number of months during which the rainfall has been deficient.

From the first two columns it appears that the years 1858 and 1864 claim the distinction of being the driest of all, the total falls being only 17·3 inches and 17·4 inches respectively, or 30 per cent. less than the average. Next comes 1847, with a total fall of 17·7 inches and a deficit amounting to 29 per cent. As regards the period of ten months, the present year has been drier than any of the past seventy-one, but in the year 1847 the rainfall was nearly as deficient. In the case of the other dry years the aggregate fall for the ten months was at least an inch more than in either 1847 or 1884, and in the years 1832 and 1837 it was three inches more. On comparing the returns for the past seventy-one years, one more striking fact is brought to light. Out of the whole series there has been only one occasion on which the deficiency of rain has continued through a greater number of months than it has this year. This long period of drought commenced in November 1846 and continued until November 1847, and there were consequently no fewer than thirteen consecutive months during which the rainfall in London was below the average.

FREDK. J. BRODIE

ANCIENT CHINESE GEOGRAPHY

NOT long since the Chinese Ambassador to England, in the course of a remarkable speech at Folkestone, twitted European scholars with the labours which they freely bestowed on the study of extinct nations and races, while the still existing civilisation of China, hardly inferior in antiquity to that of any other race, received but scant attention. Whether the charge is well founded or not we cannot pretend to decide here; but there is, we believe, no doubt that there is still in Chinese literature a vast mine, into which but few and trifling shafts have been sunk. The wealth of the geographical literature of China, for instance, is known to but a few scholars, and one of these, M. de Rosny of Paris, in a work recently published on the Oriental nations known to the ancient Chinese, says that, among all the literatures of the East, that of the Chinese probably contains the most valuable information for the study of Asiatic ethnography, for a crowd of nations which have disappeared, or which are unknown in Europe, have been the subject of substantial notices by the Chinese, outside which, probably, we know nothing of their political history or of the annals of their civilisation. M. de Rosny's work, which is published by the Ethnographical Society of Paris, is devoted to the translation and piecing together of extracts from old topographical works respecting various countries known to the Chinese in ancient times. Much of the labour in a work of this kind must necessarily be devoted to identifying the places mentioned. In many cases this has not even now been satisfactorily done. Thus, the origin of the name *Ta-tsin*, applied to the Roman Empire, is wrapped in obscurity. The latest theory is that it is the phonetical representation of Tarsus in Cilicia, whence Antoninus sent ambassadors to Bactria, so that the name of Tarsus was the first echo which China received of Rome. But although there is much in M. de Rosny's volume which can only interest the technical Sinologue, yet one can gather from the text, as well as from the maps, a fairly accurate idea of the knowledge of geography possessed by the Chinese in early times. Of the maps, which are nine in number, one contains the Indian Archipelago as known to the Chinese, and six others Indo-China and Malaysia, according to Chinese geographers, at various periods from the twelfth century before our era down to 906 after Christ.

The Chinese, then, according to M. de Rosny, have from the most remote times occupied themselves with the topography of the districts through which they migrated, and have studied the geography of the neighbouring countries. Yu the Great, who reigned in the basin of the Yellow River twenty-two centuries before our era, was a veritable geographer. The *Shu-king*, which contains an account of the public works executed under his direction, contains the first rudiments of Chinese ethnography, as Genesis does that of the Jews. A geographical work which is probably not less ancient is the *Shau-hai-king*. It is at least as old as the Choo dynasty—1134 B.C.—and some Chinese authors even carry its date back to the twenty-seventh century before Christ. In a book of rites of the Choo dynasty just referred to, it is stated that twenty-four officials were specially charged with the administration of a department for national geography. It is, however, to the historians that we have to look for accounts of the various peoples which early submitted to the preponderating influence of the Middle Kingdom. The nomad hordes of the north and west, and the States then in process of formation in the south, all entered into relations with the Chinese. The ambassadors whom they sent to the Court brought with them information as to the people they represented, which was duly consigned to the archives of the Empire by its historiographers. The officials sent by the Chinese in return to the peoples about them contributed their quota of geographical and ethnographical facts, until ultimately the documents on the subject became so numerous that native scholars judged it well to summarise them into one great work. It was thus that the great encyclopædia associated with the name of Ma-touan-lin was formed. Its first publication was in 1322.

The limits of the world as known to the early Chinese are stated by M. de Rosny to be: in the north, Southern Siberia and Kamchatka; in the east, the Kurile Islands, Japan, the Loochoo Archipelago, and that of the Philippines; in the south-east, Borneo and Celebes; to the south, Java, Sumatra, and Ceylon; to the west, Arabia, Persia, and the States bordering on the Caspian. Some scholars have professed to discover the Roman Empire under the name Ta-tsin, and America, which a mission of Shamans are said to have discovered in the fifth century, under that of Fousang. In the work before us the writer gives, from Ma-touan-lin and other sources, the statements of the early Chinese writers with regard to the various races inhabiting these regions; but he warns us more than once that these ancient documents, though of great value in teaching us about peoples little known to us, must be used with the utmost reserve, and only after undergoing a searching examination and criticism. The present instalment of the work deals only with the races to the south, south-east, and east, such as the Japanese, Ainos, Siamese, &c. Its value as an ethnographical and geographical work can only be known to the one or two living Europeans who have made a special study of the subject; but it places beyond doubt the fact that students of the ethnography and historical geography of the Far East will have to reckon with the works of their remote Chinese predecessors before their knowledge can be regarded as complete.

COLOUR

M. M. A. ROSENSTIEHL has made an interesting contribution to the science of colour in the form of a *brochure* recently published under the auspices of the Société Industrielle of Rouen, and entitled "Les premiers éléments de la Science de la Couleur." In this treatise, which is a model of brevity and of demonstrative clearness, the author shows that the empirical methods which have hitherto prevailed amongst colourists of all classes are radically imperfect. These methods are

based entirely upon the study of colouring-*matters*, and ignore altogether the fundamental distinction between colour as a property of such matter, and colour in the physiological sense of a particular affection of the organ of sight. It is to the study of colour by means of colour-sensations that our attention is directed; and it is to the synthesis and analysis of the retinal impressions that we are to look for exact views on the relationships of the colours. The distinction in question once stated is so obvious that the author's claim for recognition of the new system or method as the necessary complement of the older will be at once admitted. But the author's aim is not so much to obtain the intellectual assent of those accustomed to the propositions of abstract science, as rather to convince colour-artists of every denomination of the direct utility of the method—to show them, in fact, that it supplies the means of solving problems in colouring with rapidity and certainty, and furnishes valuable criteria with which to strengthen the æsthetic judgment.

The chief obstacles to the general acceptance of the method lie in the erroneous views which underlie the well-worn proverb, "Il ne faut pas disputer des gouts et des couleurs." While, in opposition to these tenets, the author contends for the admission of more positive views, and of the experimental method upon which they are based, he very distinctly disclaims the idea of substituting taste and artistic inspiration by a set of mathematical rules. "Taste," he says, "must ever remain the supreme judge of the æsthetic value of any combination of colours."

It is true that the artistic instinct confers upon its possessor a comparative independence of the methodical selection of colour; but this instinct, or intuitive perception of harmony, is by no means an unerring guide, nor without the influence of prevailing ideas. Most of these are of necessity incomplete, and many are demonstrably false: and the artistic instinct therefore needs development and correction. In the abstract which we shall give of the author's treatise, we shall give due prominence to the evidences of these shortcomings.

The elaboration of the empirical system still prevalent we owe to Chevreul. It is based entirely upon the study of colouring-matters, and its scales of colour-relationships are purely arbitrary. The theoretical treatment of colour, on the other hand, has been chiefly, and indeed necessarily, confined to the investigations of the spectrum. Early in this century, Young, the father of our modern science of light, formulated a theory of colour-sensation, a theory, that is to say, which co-ordinated the physical phenomena of coloured light with the phenomena of its appreciation by the eye. Colour, we know, is the expression of wave-length; the sense of colour was referred by Young to the agency of distinctive retinal nerves, each endowed with the capacity of selective excitation by rays of certain wave-lengths. He recognised, further, three primary divisions of wave-lengths, corresponding to red, blue, and yellow light. The later researches of Maxwell have given results confirmatory of this view, and additional testimony to the wonderful insight of this great philosopher. But we are not concerned at this moment with the theories and speculations of pure science so much as with the more practical question of the advantage to the colourist of correcting impressions derived from the empirical study of pigments, by the study of colour in the light of their main results and consequences. A very praiseworthy effort to bridge over the gap which had so long existed between the science and the art of colouring has been made by Prof. von Bezold in the publication of his work on the "Science of Colour." This excellent treatise, in spite of its translation into English, has, we think, not received the attention in this country which it deserves; this is accounted for in part by its publication in America, but an equally powerful cause is to be found in the conservatism of those to whom it appeals, in the jealousy of invasion by the forces of a new method of a territory rendered sacred by inheritance.

In both treatises considerable importance is attached to the reduction of the various terms in conventional use to the accurate expression of the ideas involved in the scientific investigation of colour. This is a task of considerable difficulty.

M. Rosenstiehl finds the French terms especially difficult to handle. The three principal substantives, *nuance*, *teinte*, and *ton*, he assigns—though with a confession that his choice is somewhat arbitrary—to the three variables respectively which determine a colour, viz. kind or quality (*espèce*), intensity, and purity. In this choice he admits that the terms *ton* and *nuance* may be said to have an inverse relationship to that which they occupy in musical language, but at the same time justifies the selection as most in accordance with present usage, pointing out, moreover, that the analogy between the ear and the eye is so slender that it is not to be sought in the terms which express their sensations. The translator of Bezold finds himself called upon to accommodate himself in his treatment of the subject to the use of the terms hue, tint, shade. To avoid prolixity we give as the result of a careful consideration of the terminology of both authors the following definitions of essential terms:—

(1) Colour in the sense of wave-length must be denominated by *hue*.

(2) The degree of brightness (French, *intensité*) we may express by *tint*.

(3) The degree of purity, *i.e.* non-admixture with white, may be rendered by *tone*.

It is obvious that (2) and (3) are, in regard to the ordinary conditions of vision, interdependent variables, for, as the intensity or illumination increases, the proportion of white increases.

It will be found on trial that, by means of these three substantives, the essential factors of any colour may be expressed. It is clear that habit will prevent our specialising the use of the word colour; but we may limit its use scientifically to the general expression of primary distinctions, reserving the term hue to indicate specially wave-length and variations in wave-length. There still remains, however, the important word *shade* to dispose of, amongst the substantives in conventional use, as well as the numerous adjectives with which they have been conjoined.

The more general use of *shade* has been to express the idea contained in (3), *i.e.* the toning of colours by addition or removal of white, and this use may be retained. At the same time, in order that our nomenclature may be precise, we must obviously avoid such expressions as a "red *shade* of orange, using instead "red-orange hue," or even "red hue of orange," or again, "dark *shade* of green," meaning thereby a green of medium tone perhaps, but of low illumination; the correct expression here would be "a green, a *dark* or *low tint*" (*couleur foncée*).

The term *couleur saturée* is applied by M. Rosenstiehl to a pure colour, or the corresponding visual sensation: such colours are obviously never met with in the arts; those which approximate to saturation he terms *couleurs franches*. These adjectives are perhaps best translated by *integral* and *full* respectively.

The spectral hues are *integral; full* colours or tones are those which give the impression of quantity of colour.

The term *gamut* or *scale* is used in two senses: first, to indicate a graduated succession of tones, *i.e.* the gradations of a given hue through its several tones to white; and second, a graduated succession of tints, or the gradations of a given hue through its several tints to black.

The *æsthetic gamut* or *scale* is the term applied by the author to graduated modifications of one and the same colour-*sensation*; its special significance will become

more apparent as we proceed in our examination of M. Rosenstiehl's work.

For the investigation of colours, or rather of colouring-matters, the author employs concentric disks, which are kept in rapid rotation by mechanical means of the simplest character. These disks may be coloured uniformly or in sectors of various hues; the well-known result of the rapid rotation is in the latter case the mixture of the sensations velvet. The admixture of black is then produced by cutting from the disk a sector; the disk being then placed before this chamber adds the sensation of black to that of colour in the proportion of the size of the sector removed to that of the disk. A special apparatus is described for measuring the sectors of the disks, as is also the very necessary instrument by which the disks are cut with or without the simultaneous removal of sectors.

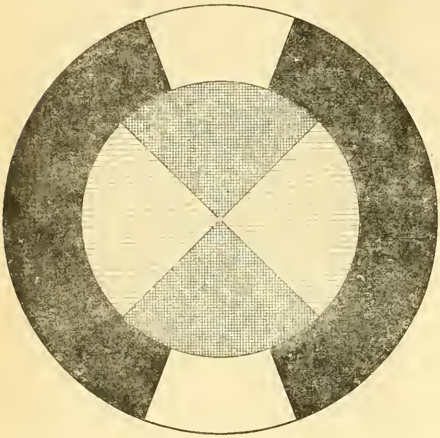


Fig. 1.

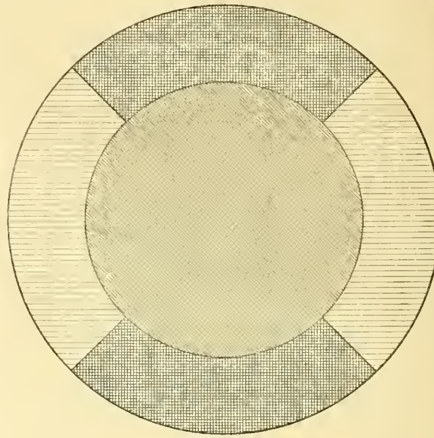


Fig. 3.

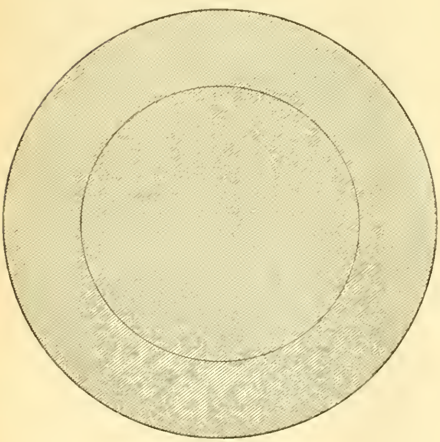


Fig. 2.

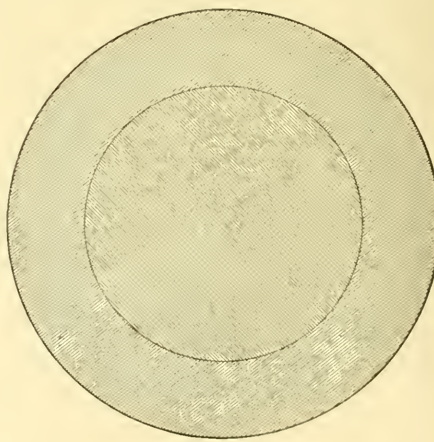


Fig. 4.

of light, then fusion into a single uniform coloured impression. In the study of the degradation of colours by admixture, it is necessary to have both a black and a white. The white is obtained by means of precipitated barium sulphate applied to a suitable surface; the black is obtained by means of a small chamber before which the disks rotate, this chamber being lined with black

The author's experimental results are given in a series of coloured plates, to which descriptive notes and explanations are attached. Some of these we proceed to reproduce. Plate I in the book is a study of complementary colours or hues. The superposed disks are represented both at rest (Fig. 1) and in motion (Fig. 2); the mechanical details, such as the attachment of the disks to the re-

volving axis, are suppressed for the sake of clearness. Under the condition of rapid rotation both disks appear to be coloured a uniform grey.

Thus in a single experiment is demonstrated (1) that blue and yellow are complementary colours, (2) that particular tones of blue and yellow produce by mixture of retinal impressions a white of low tint—in fact, by measuring the sectors composing the outer annulus, a white of 2-9ths the intensity of that of the annulus, which is produced by barium sulphate. Other binary combinations will be found to produce similar results, *e.g.* red and blue-green, violet and yellow-green. In fact given any hue, a second may be formed by means of this apparatus, such that the combination of the retinal impressions proper to each shall produce the sensation of white, the degree of this sensation varying with the tone of the constituents of the combination.

From the experimental investigation of complementary hues the definition of intensity is readily deduced. In the sectors of the plate we notice equality of area. Had we taken a fuller yellow of the same hue, the grey produced with the blue sector of equal area would have shown a yellow cast, and to restore the neutral grey or low white we must increase the area of the blue at the expense of the yellow. The relative intensity of complementary hues is thus defined to be the reverse of the sectors necessary to produce neutrality of hue.

The use of the particular yellow pigment of Fig. 1, coloured in the original chromate of lead, is dictated by the lowness of tints of all our blue pigments; the purest of our ultramarines, smalts, and aniline blues do not possess one-third the intensity of chromate of lead; and the same is true of the greens and violets.

The study of complementary colours leads directly to the discussion of the basis of this phenomenon, whether, *i.e.* it is physical or physiological? It is in this department of the subject that confusion of ideas has longest persisted. Although it was pointed out by M. Plateau as long ago as 1829 that the mixture of colouring-*matters* and of colour-*sensations* are distinct phenomena, the classical experiment of Muschenbroek, dating from 1762, is still retained by lecturers and text-books, together with erroneous interpretations. Newton himself fell into the same error in his discussion of the recombination of the spectral colours. The author puts the matter in the clearest light by pointing out that there are a number of mixtures producing the sensation of white light,—that psychological identity, therefore, is no criterion of physical identity.

The distinction is perhaps most clearly demonstrated by a plate of figures representing the superposed disks at rest and in motion. The outer annulus is composed of alternate and equal sectors of blue and yellow, the inner disk being coloured with a mixture of blue and yellow pigments in equal proportions. The distinction in appearance produced by motion affords the clearest demonstration of the point in question (Figs. 3 and 4).

The next portion of the treatise is devoted to the study of mixtures of colours, *i.e.* colour-sensations, which are not complementary. The more important results are those obtained in the so-called "degradation" of pigments. Such pigments, for instance, when applied to a white surface, will be more or less mixed with white, *i.e.* the sensations of white will be more or less conjoined with that of the pigment hue, as the quantity of pigment per unit of surface is less. The author reproduces series of such tones, in the case of Prussian blue and chrome yellow, together with their respective complementaries. In both cases it is found that the progression is accompanied by an alteration in hue, the fuller tones being distinctly redder. It is clear, therefore, that to construct a scale or gamut of tones with any given pigment, in order that this shall have an æsthetic or standard value, each tone must be referred to the same complementary, and the tones due to the pigment alone will need correction in accordance with their demonstrated imperfections, *i.e.* departures from the standards determined by the method of physiological comparison.

The author has very carefully compared such scales of tones with the purely arbitrary scales of M. Chevreul, and has found the differences to be considerable. Such indeed might be inferred indirectly from M. Chevreul's definition of "the tones of a colour"; they are, according to him, "the different degrees of intensity of which a colour is susceptible according as the *substance* by which it is produced (*représenté*) is pure or mixed with white."

A comparison of colour combinations harmonised according to the two systems, will show the æsthetic superiority of the physiological method, judged, that is, by the much abused arbiter, *taste*. It is unnecessary further to insist upon the practical importance of such conclusions. It will doubtless have been already appreciated on the part of the reader that the confusion of ideas which it is the object of this treatise to eliminate cannot have remained without influence upon the education of the eye; nor can he fail to see that the training involved in the practice of the author's experimental method is a valuable æsthetic discipline, as well as a precise study of colour relationships.

We have attempted to give an idea of the difference in appearance of the disks by lines on a white surface.

THE LATE FERDINAND VON HOCHSTETTER

THE numerous friends and admirers of the late Dr. Ferdinand von Hochstetter in Europe and Australasia have to thank his old associate, Dr. Julius von Haast, for a graceful tribute paid to his memory, which takes the form of a sympathetic biographical notice published towards the end of last August at Christchurch, New Zealand. The memoir, which is accompanied by two portraits, from a lithograph and a photograph showing the distinguished naturalist in his twenty-ninth and fiftieth years respectively, is taken for his early career partly from an account in Brockhaus's "Conversations Lexicon," and for the period since the two friends first met at Auckland, N.Z., in 1858, from Hochstetter's writings and private correspondence. Born on April 30, 1829, at Esslingen, Wurtemberg, the future naturalist was at first intended for the Church by his father, Prof. Christian Ferdinand Hochstetter, chief pastor of that town, and himself a botanist of no mean repute. But in the seminary of Maulbronn near Tübingen, his love of science, implanted in the paternal home, grew so strong that, besides theology, he applied himself with great zeal to the study of mineralogy, palæontology, and geology. After taking his degree of Doctor Philosophiæ in 1852 he seems to have finally made choice of a scientific career, and in 1853 found employment on the Geological Survey of the Austrian Empire, soon after receiving the appointment of Chief Geologist for the Bohemian Section. His reports on the geology of the Boehmer Wald were so highly appreciated that he was selected in 1857 as geologist of the *Novara* Expedition, which brought him to Auckland on December 22, 1858. Here his services were at once secured by the Government, and with the reluctant consent of the Commodore of the *Novara* he accepted an engagement of eight months to examine the geology, physical features, and natural history of New Zealand. During this period he made extensive topographical and geological surveys of the provinces of Auckland and Nelson, the results of which were embodied in his standard work, "Neu Seeland," published in 1863, followed in 1867 by the greatly enlarged English edition dedicated to the Queen. Soon after his return to Europe he was appointed Professor of Geology and Mineralogy in the Technical University of Vienna, and after a visit of some months to England in 1860 he settled permanently in the Austrian capital, where, in April 1861, he married

Georgina Bengough, daughter of the English director of the Vienna gas-works. A visit in 1863 to Vesuvius was followed next year by the appearance of the "Geology of New Zealand" and of the "Palæontology of New Zealand," both of great scientific value, and forming his main contributions to the extensive series of the *Novara* publications.

About the same time Hochstetter was commissioned to explore the lacustrine basins in Carinthia and other parts of Austria, where he discovered numerous remains of kitchen-middens and prehistoric lake dwellings similar to those found in the lakes of Switzerland. In 1867 he was elected President of the Imperial Geographical Society of Vienna, a position which he held till compelled by his failing health to resign it in 1882. He now commenced the publication of a whole series of geological and mineralogical text-books for higher schools, which were introduced into many parts of the Austrian Empire, and one of which, on crystallography, was especially distinguished by its clearness and thorough grasp of the subject. Time was now also found to complete his geological essays on the Cape of Good Hope, the Island of St. Paul, the Nicobars, and Java, for the *Novara* series, and also to publish an interesting account of the great earthquake and sea-wave of 1868, in the southern hemisphere, including a calculation of the mean depth of the Pacific deduced from the known velocity of the waves across that ocean. The appointment of Consulting Geologist to the Turkish Great Railway Company brought him in 1869 to the Balkan Peninsula, the results of which journey soon after appeared, partly in the *Proceedings* of the Vienna Geographical Society, partly in the *Year-Book* of the Imperial Geological Institute, and in *Petermann's Mittheilungen*. For these important geological surveys he was decorated by the Sultan with the order of the Mejidié. Notwithstanding the loss of his eldest daughter Julia in 1871, and a chronic affection of the throat, his scientific writings and surveys were now continued with unflagging zeal, including a handbook of geology which formed part of the "Allgemeine Erdkunde"; an atlas of twenty-four geological pictorial views, with letterpress; much harassing work in connection with the Viennese International Exhibition of 1873; and lastly, an arduous journey of over two months in the summer of 1872 to the Urals and Siberia as consulting geologist to a large mining association. Then came his honourable appointment as teacher of science to Crown Prince Rudolph in 1872, followed in 1875 by his election to the Rectorship of the Technical University, and in 1876 to the position of Imperial Intendant (Chief Curator) of the Imperial Austrian Museum of Zoology, Ethnology, and Natural History. He had hoped to witness the completion of this magnificent building, which has been in progress for many years; but, although it was nearly ready for occupation as early as the summer of 1881, he did not live to see it opened to the public. In the interests of the Museum he visited Denmark, Holland, Belgium, and North Germany in 1876, and was soon after busily engaged superintending excavations in Carinthia, Bohemia, and other parts of the empire, which resulted in the discovery of rich palæontological and archæological treasures, prehistoric burial-places, skeletons of the extinct cave bear, remains of fossil man, a large number of bronze ornaments, weapons, and implements. Towards the end of 1879 his health began to decline. He suffered much about this time from pains in the legs and arms, accompanied by sleeplessness and other symptoms which later developed into an incurable attack of diabetes, terminating on July 21 last a laborious and blameless life devoted entirely to the advancement of the natural sciences. Indefatigable to the last, he found time in the midst of his multifarious labours to issue a report in 1883 on some Mexican antiquities discovered by him in the Ambrose Collection in Tyrol, and which had originally been sent by Fernando Cortez to the Emperor Charles the Fifth. His last contribution to science was a paper read in February of the present year before the Vienna Geological Institute, giving an instructive account of the celebrated mineralogical collection now removed to the New Imperial Museum. Hochstetter's life may thus be described as an epitome of the history of the natural sciences in Austria during the last quarter of a century. Dr. von Haast's appreciative memoir concludes with the appropriate lines from Goethe:—

> "Fest steh' dein Sarg in wohlgegönnter Ruh;
> Mit lockrer Erde deckt ihn leise zu,
> Und sanfter als des Lebens, liege dann
> Auf dir des Grabes Bürde, guter Mann!"

NOTES

PROF. G. H. DARWIN, of Cambridge, and Prof. Daniel Oliver, of the Royal Gardens, Kew, have been nominated by the Council of the Royal Society for the award of the two Royal Medals conferred by the Crown. The Copley Medal is to be given to Prof. Carl Ludwig, of Leipzig, in recognition of the great services which he has rendered to physiological science. Prof. Tobias Robertus Thalén, of Upsala, is to have the Rumford Medal for his spectroscopic researches; and the Davy Medal is awarded to Prof. A. W. H. Kolbe, also of Leipzig, for his researches in the isomerism of alcohols. The two Leipzig Professors are Foreign Members of the Society. Prof. Darwin and Prof. Oliver are Fellows, the former well known for his mathematical investigations on the rigidity of the earth and on tides, the latter for his investigation of the classification of plants and for the important services which he has rendered to taxonomic botany.

IN speaking recently at the Academy of Music in Philadelphia to a large audience on the wave-theory of light, Sir William Thomson made the following remarks on the employment of the metrical system:—"You, in this country, are subjected to the British insularity in weights and measures; you use the foot, and inch, and yard. I am obliged to use that system, but I apologise to you for doing so, because it is so inconvenient, and I hope all Americans will do everything in their power to introduce the French metrical system. I hope the evil action performed by an English Minister whose name I need not mention, because I do not wish to throw obloquy on any one, may be remedied. He abrogated a useful rule, which for a short time was followed, and which I hope will soon be again enjoined, that the French metrical system be taught in all our national schools. I do not know how it is in America. The school system seems to be very admirable, and I hope the teaching of the metrical system will not be let slip in the American schools any more than the use of the globes. I say this seriously. I do not think any one knows how seriously I speak of it. I look upon our English system as a wickedly brain-destroying piece of bondage under which we suffer. The reason why we continue to use it is the imaginary difficulty of making a change and nothing else; but I do not think in America that any such difficulty should stand in the way of adopting so splendidly useful a reform."

IT is stated that Lord Rayleigh has resigned the Cavendish Professorship of Experimental Physics. The electors are Sir W. Thomson, Sir William (Justice) Grove, Profs. Liveing, Stokes, Darwin, R. B. Clifton (Oxford), and Stuart, and Mr. W. D. Niven.

DR. THOMAS WRIGHT, F.R.S., of Cheltenham, died on the night of Monday last. This sad announcement will be received with much regret by all who take interest in the progress of geology and palæontology. We hope to give some account of the deceased naturalist next week.

THE presentation of prizes and certificates to the students of the Finsbury Technical College, and of the South London School of Technical Art, and also to the candidates at the Technological Examinations held this year in London will take place at the Fishmongers' Hall on the 4th proximo at 7.30 p.m. The Lord Mayor will preside, and the prizes will be presented by the Lord Chancellor.

NEWS from Japan states that Prof. Milne, of Tokio University, is about to establish a subterranean observatory at Jacashima, a very deep coal-mine not far from Nagasaki. The object of this observatory is to determine what connection exists between the earthquake phenomena and meteorological phenomena belonging to the earth's surface, such as storms, barometrical pressure, tides, tidal waves, &c.

M. HANSEN-BLANGSTED contributes to *L'Exploration* an interesting article on the struggle between trees in the Danish forests. The chief combatants are the beech and the birch, the former being everywhere successful in its invasions. The paper refers especially to the district of Silkeborg in the heart of Jutland. Forests composed wholly of birch are now only found in sterile sandy tracts; everywhere else the trees are mixed, and wherever the soil is favourable the beech rapidly drives out the birch. The latter loses its branches at the touch of the beech, and devotes all its strength to its upper part, where it towers above the beech. It may live long in this way, but it succumbs ultimately in the fight—of old age if of nothing else, for the life of the birch in Denmark is shorter than that of the beech. The writer believes that light is the cause of the superiority of the latter, for it has a greater development of its branches than the birch, which is more open, and thus allows the rays of the sun to pass through to the soil below, while the tufted, bushy top of the beech retains them, and thus preserves a deep shade at its base. Hardly any young plants can grow under the beech except its own shoots; and while the beech can flourish under the shade of the birch, the latter dies immediately under the beech. The birch has only been saved from total extermination by the facts that it had possession of the Danish forests long before the beech ever reached that country, and that certain districts are unfavourable to the growth of the latter. But wherever the soil has been enriched by the decomposition of the leaves of the birch the battle begins. The birch still flourishes on the borders of lakes and other marshy places, where its enemy cannot exist. In the same way in the forests of Zeeland the fir forests are disappearing before the beech. Left to themselves the firs are soon replaced by the beech. The struggle between the latter and the oak is longer and more stubborn, for the branches and foliage of the oak are thicker, and offer much resistance to the passage of light. The oak also has great longevity, but sooner or later it, too, succumbs, because it cannot develop in the shadow of the beech. The earliest forests of Denmark were mainly composed of aspens, with which the birch was apparently associated; gradually the soil was raised and the climate grew milder; then the fir grew and formed large forests. This tree ruled for centuries, and then ceded the first place to the holm oak, which is now giving way to the beech. Aspen, birch, fir, oak, and beech appear to be the steps in the struggle for the survival of the fittest among the forest trees of Denmark.

WE learn from *Science* that the U.S. Signal Service is about to undertake the publication of a general bibliography of meteorology and allied topics (such as earthquakes, terrestrial magnetism, and meteors), and requests from the writers of all countries a complete list of their contributions to the literature of these subjects, including the titles of all separate works, papers, and published observations. The number of titles already on hand is about 35,000. Especial attention is invited to the importance of full titles, with details of size, and place and date of publication. References to periodicals should be on this pattern:—

"Quetelet, Lambert Adolphe Jacques,
Sur les orages du mois d'Avril, 1865.
Bruxelles, *Acad. Sci. Bull.* XIX., 1865, 535-537."

Correspondence should be addressed to the Chief Signal Officer, U.S. Army, Washington.

ERMANNO LOESCHER of Turin has just issued the fifty-first catalogue of the literary treasures contained in his "Libreria Antiquaria." The present number is devoted chiefly to geography, travel, and antiquities, and the contents are conveniently arranged under four heads: America, Africa, China with Japan, Geography and Travels. Amongst the entries, which number 429 altogether, the bibliophile will find much to interest him.

HERR J. OLSEN, a Norwegian botanist, who has been studying the fungi in the vicinity of Bergen during the summer, has found a *Gomphidius gracilis* at Hovland. This variety has never before been found in Scandinavia, and belongs to England. Of other varieties new to Norway which he has discovered may be mentioned *Rhizopogon luteolus* and a *Boletus*. The flora of Tysnæs Island is stated to be identical with that of England.

THE following letter has been received by Prof. E. Ray Lankester, F.R.S., the Secretary of the Marine Biological Association, announcing a donation from the Royal Society in aid of the fund (now approaching 5000*l.*) which is being raised for the purpose of building and fitting a marine laboratory and experimental aquarium at Plymouth:—"Royal Society, Burlington House, London, W., Nov. 1, 1884. Sir,—Your letter relative to the Marine Biological Association was laid before the Council at their meeting on Thursday last, and I am directed to inform you that the Council have voted the sum of 250*l.* from the 'Donation Fund' in aid of the 'Marine Biological Association,' as a token of their sympathy with an effort which, they have every reason to believe, will contribute largely to the progress of biological science in this country.—I beg to remain, yours obediently, M. FOSTER, Sec.R.S."

AMONG other interesting papers in the *Proceedings* of the Perthshire Society of Natural Science for 1883-84 we notice: dimorphism in oak-gall makers and in their galls, by Prof. J. W. Trail, F.L.S.; evolution and some things said regarding it, by Rev. G. Milroy, D.D., in which a "creative" and "spontaneous" view of the origin of life is discussed with studied dispassionateness. We are glad to observe the flourishing state in which this Society seems to be.

PROF. DE LACOUPERIE is bringing to a conclusion a work on the aboriginal and non-Chinese races of China, which will be published shortly by Messrs. Field and Tuer. It will deal with one section of the learned author's researches into the *origines Sinicæ*, in which he has been engaged for several years, and which have been so successful in some important respects. One of the most curious results of the work will be to demonstrate the real youth of the Chinese as a homogeneous and powerful people. It is based wholly on original researches into Chinese literature, and this is, we believe, the first time that the ethnology of early China has been studied from the works of the Chinese themselves, or indeed at all. The work deals with the various tribes which have successively occupied China proper, and which are intimately connected with the Indo-Chinese races, the latter being in fact the modern representatives of the early occupants of China. The originality of the subject, as well as of the sources from which it is treated, should render the volume one of great scientific and general interest. The work was originally prepared as an introduction to Mr. Colquhoun's new book "Among the Shans," but it gradually

grew to such an extent under its author's hands that it became too large for such a purpose, and this, as well as its independent value, rendered it desirable to have a separate publication. Mr. Colquhoun's volume, which is on the point of publication, will, however, contain an introduction by Prof. de Lacouperie on the cradle of the Shan race, which, curiously enough, he places far away on the borders of Shensi.

Prof. Enrico Caporali continues to develop the scheme formulated in the first number of *La Nuova Scienza* with great vigour and learning. The third number, for the quarter ending September 1884, shows even greater energy and grasp of the subject than its predecessors. The editor's views are now quite clear—opposition alike to the two extremes of materialism and dogmatism, and the establishment of a new philosophy reconciling the subjective methods of the old schools with the objective standpoint of the new. Evolution in the Darwinian sense is accepted without reserve, and the germs of life are sought in the very lowest forms of matter—the crystal, the molecule, and the atom itself. Thus evolution receives its broadest expression, and begins from the very first as well for the vital force as for crude matter itself. The first genesis of psychis is in fact referred to a unity arising out of the fusion of lower chemical species in a higher chemical species, which forms the connecting link between *chemical* and biological psychogenesis. In it individuals begin to react in such a way that the opposition between subject and object may almost be said to have already begun. The theory is ingenions and skilfully worked out; but the unusual interest taken on the Continent in this periodical is probably due mainly to the remarkable learning, clearness, and consistency with which the editor's views are advocated. In the present number the chief articles are: —Modern Italian Thought, the Pythagoric Formula of Cosmic Evolution, and the French Anti-Clerical Evolution.

A high-level meteorological station has been recently established by Mr. Wragge on Mount Lofty, about 2200 feet high, and ten miles from Adelaide, South Australia. With Mr. Wragge's great energy and ability valuable results will doubtless be obtained from this new high-level station in connection with the excellent meteorological service of the colony.

In the Report on Weights and Measures presented to Parliament by the Board of Trade, under the Weights and Measures Act, 1878, Sir T. H. Farrer remarks in reference to the metric system, that an opinion has been expressed by the Board of Trade that the time has now arrived when this country might with advantage join the International Convention on Metric Standards, under proper conditions; provided such a course is not to be taken as an adhesion, on the part of the United Kingdom, to the metric system. These observations appear to be intended as a reply to the eighth resolution of the Conference of the International Geodetical Association, held in Rome in October last, which expresses a hope that, if the rest of the world accepts the meridian of Greenwich for the unification of longitude, England will find in this agreement an additional motive for taking a new step in favour of the unification of weights and measures, by adhering to the Metrical Convention of May 20, 1875.

Two years ago Prof. O. Sars, of Christiania, was given some mud taken from the bottom of a lake in Australia by Dr. Lumholtz, a Norwegian geologist. Recently he has made experiments with the same in small aquaria, and has succeeded in producing from the dried mud quite a fauna of Australian freshwater invertebrates.

According to *L'Exploration*, Commander de Amezaga, of the Italian navy, has handed to the Ministry of Marine at Rome the collections made during the recent voyage of the corvette *Carracciolo*. The voyage lasted more than two years and a half, during which time she touched at Montevideo, Valparaiso, Callao, Guayaquil, Sydney, Singapore, and Aden. Important hydrographical investigations were made in the Straits of Magellan and on the coasts of Fiji, Tahiti, and among the islands of the South Pacific. The collections relate principally to anthropology, ethnology, the fauna and flora of Peru and Australia, Peruvian pottery, mineralogy, and zoology. In the Anthropological Section there are three Peruvian mummies in perfect preservation, although they probably date back a thousand years before the Spanish Conquest. They are distinguished from the Egyptian mummies by being in a crouching position instead of at full length. In the Ethnological Section there is a curious specimen of Carib art found at the summit of Mont Cristi, near Guayaquil.

The *Times* announces the death of the celebrated naturalist and traveller, Dr. Alfred Brehm, in his fifty-fifth year. The son of a Thuringian ornithologist, he devoted much of his own attention to the study of birds, but all animal nature was his province, and his observations and researches are recorded in volumes of high importance and value. While still a very young man he spent several years in the north-east districts of Africa, and later in life undertook frequent scientific tours in distant lands, including a visit to Siberia and Turkestan. In 1862 he accompanied the Duke of Coburg-Gotha to Abyssinia, and in 1877 acted as scientific guide to Prince Rudolph in the country of the Danube. The deceased was for some years Director of the Zoological Gardens at Hamburg.

A magnificent meteor was observed at Mülheim, on the Rhine, on the evening of October 30 last. Its direction was from north-east to south-west, its duration two to three seconds. While visible its progress was accompanied by a hissing sound, and it finally exploded with a loud report and brilliant blue-reddish light, leaving a bright trail behind which was still visible half a minute later.

Two prehistoric tombs have been recently opened near the villages of Latdorf and Gröna near Bernburg (Germany), under the direction of Prof. Virchow. Three skeletons, an urn, a comb, a bronze ring, a flint knife, and half a horseshoe were found. The excavations have now been continued under Dr. Fischer's direction, and more objects brought to light, among others curious necklaces made of the teeth of bears, wolves, and foxes. The age of the tombs is said to be over 3000 years. The objects found will be preserved in the museum of the Bernburg Antiquarian Society.

We have received from Mr. Henry Simon, of Manchester, a copy of a pamphlet by Mr. Breckon, Mr. Simon's representative for the Cleveland district, on the question of the manufacture of metallurgical coke in connection with the saving of the by-products. An account of the present position of the question in England is added, as well as a reprint of papers on the subject read by Mr. Simon, Mr. Dixon, and Mr. Smith before the Iron and Steel Institute and the British Association.

The tobacco plantations of Southern Hungary are threatened by a terrible pest, viz. the so-called wire-worm, which differs from the ordinary tobacco-worm, inasmuch as it enters the stem of the plant just above the root and then works its destructive way right up to the flowers. Plants thus attacked yield no tobacco whatever, as the leaves turn yellow and fall shortly after the worm has attacked the stem. The tobacco-worm merely attacks the root. The large plantations of Maslak, which are celebrated for their excellent produce, have been nearly all destroyed this year by the wire-worm, while in other districts the tobacco-worm has done much damage.

A LARGE Horticultural Exhibition is to be held at Berlin in September 1885.

A COFFEE plantation has been established by a landowner in the neighbourhood of Rome. It is stated that he realised a fair profit with this year's harvest, which consisted of 2 tons of coffee per hectare.

A NEW mud-crater has formed at the foot of Mount Etna, measuring some 500 metres in diameter. The mud ejected by it flows towards Monte Furmento and the pine forest of Biancavilla.

THE additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii* ♀) from South Africa, presented by Mr. J. A. Cameron; an Asiatic Wild Ass (*Equus onager* ♂) from South-Western Asia, presented by Lieut.-Col. R. A. Crawford; a Short-eared Owl (*Asio brachyotus*), a Lesser Kestrel (*Tinnunculus cenchris*) from Griqualand West, South Africa, presented by Mrs. L. Weil; a Common Cormorant (*Phalacrocorax carbo*), British, presented by Mr. S. S. Mossop; a Macaque Monkey (*Macacus cynomolgus*) from India, deposited; two Tasmanian Wolves (*Thylacinus cynocephalus*) from Tasmania, a Reindeer (*Rangifer tarandus* ♂) from Labrador, a Golden-winged Woodpecker (*Colaptes auratus*) from North America, a South American Rat Snake (*Spilotes variabilis*) from South America, purchased.

OUR ASTRONOMICAL COLUMN

THE SATURNIAN SYSTEM.—Dr. W. Meyer, late Assistant Astronomer at the Observatory of Geneva, has published in t. xxix. of *Mémoires de la Société de Physique et d'Histoire Naturelle de Genève* a determination of the dimensions of Saturn's rings and of the orbits of six satellites, and the mass of the planet, founded upon observations made at the Observatory, with a filar-micrometer on the Merz refractor of 10 inches aperture, presented to that institution by the late Prof. Plantamour. The observations in question were made during the opposition of 1881, and upon a system which it was believed would give the measures a superiority over those obtained with the same instrument in the previous year. The memoir on Saturn and his satellites, which has been separately published, is preceded by a very minute description of the Plantamour equatorial by Prof. Thury. The measures are printed in detail with the elements of reduction employed; they extend from August 15 to December 19. Dr. Meyer considers that Mimas was certainly observed on five nights, though he remarks: "Même dans la colossale lunette de Vienne, c'est un objet très délicat, qui est rarement visible quand il n'est pas près d'une élongation." On November 4, at 10h. 31m., a very faint object was observed, approximately in the position—$x = 254''$, $y = -35''$, which, by means of Prof. Asaph Hall's ephemeris, Dr. Meyer identifies as Hyperion. In the discussion of the orbits of the satellites (Enceladus, Tethys, Dione, Rhea, Titan, and Japetus) provisional elements are assumed, and are corrected in the usual manner by equations of condition. In order to determine the mean motions, the Geneva results are compared with those of Bessel in the case of Titan, while for other satellites the comparison is made with the epochs deduced by Jacob from his measures at Madras in the years 1856–58, it being considered that, in view of the precision attaching to them, little would be gained by having recourse to the older observations, especially as difficulties attend their explanation in many cases.

The mass of the ring is concluded to be very minute, certainly very much less than the value assigned by Bessel; it is stated that with the aid of Tisserand's theory, taken in connection with the results of observation, $\frac{1}{1647}$ was found for a higher limit. The most probable mass of the planet deducible from the Geneva observations is $\frac{1}{3482\cdot5}$, agreeing within the probable error with that assigned by Jacob, and that derived by Prof. Asaph Hall from the Washington measures of Japetus.

The following are the periods of the satellites and their mean distances from Saturn, determined by Dr. Meyer:—

	Sidereal revolution d. h. m. s.	Mean distance In arc ″	In equatorial radii of Saturn
Enceladus ...	1 8 53 6·92 ...	34·350 ...	3·866
Tethys ...	1 21 18 25·62 ..	42·751 ...	4·812
Dione	2 17 41 9·29 ...	54·757 ...	6·163
Rhea	4 12 25 11·57 ...	76·484 ...	8·608
Titan	15 22 41 23·16 ...	176·910 ...	19·911
Japetus ...	79 7 49 24·84 ...	514·711 ...	57·930

THE VARIABLE STAR U GEMINORUM.—Mr. Knott has succeeded in observing another maximum of this irregular variable, which appears to have taken place on October 22, though there was very little change for four days after that date. On October 18 it was below 13·3 m. From his previous observations compared with this one, Mr. Knott infers that there has been a double period in 160 days.

ENCKE'S COMET.—M. Otto Struve has notified that an ephemeris of this comet, extending from the beginning of the present month to the beginning of May next, has been prepared by Dr. Backlund, and that it was intended to communicate it to astronomers direct from Pulkowa.

WOLF'S COMET.—M. Gonnessiat, of the Observatory at Lyons, has calculated elements of this comet from observations extending over forty-five days: he finds the period of revolution 6·862 years. The following ephemeris is deduced from his orbit:—

At Paris Midnight

	R.A. h. m. s.	N.P.D. ° ′	Log. distance from Earth	Intensity of light
November 21	22 57 13	93 6·0	0·0035	0·74
23	23 2 11	93 31·4		
25	23 7 11	93 54·9	0·0169	0·70
27	23 12 13	94 16·4		
29	23 17 18	94 36·0	0·0300	0·65
December 1	23 22 23	94 53·8		
3	23 27 30	95 9·8	0·0425	0·61

The intensity of light on September 21 is taken as unity.

GEOGRAPHICAL NOTES

AT the last meeting of the French Geographical Society Dr. Paul Heis read a paper upon the results of his journey through the valley of the Meikong, and further north into the unexplored region which separates Indo-China, properly so-called, from Tonquin. Dr. Heis has made several discoveries likely to be of service to anthropologists, geologists, and mineralogists, and has brought back with him a collection of insects and reptiles, as well as a meteorological register, which was checked four times a day during the whole of his journey. Leaving Saigon on December 12, 1882, he ascended the Meikong as far as the 18th parallel, at which point he turned off from the main stream in order to go up its affluent, the Nancham, and endeavoured to reach Luang-Prabang through the hitherto unexplored region known in Annam as the principality of Tranninh. This region is infested by Chinese brigands, called Hos, who drove him back to the Meikong, and seized the greater part of his baggage. Reascending the river to Luang-Prabang he remained there for eight months, exploring the country in various directions, notably along the Nancham, which took him close to the region of the Hos, so that he was again compelled to retrace his steps. Being prevented from returning eastward, he went through the Siamese part of Burmah, reascended the Meikong as far as Chieng-sen, thence, passing from the basin of the Meikong to that of the Meinam, he reached Chieng-mai, and so made his way on foot to Bangkok, following the course of the Meinam. From Bangkok he went to Chantalun, on the west coast of Siam, and thence on foot to Baltambang, traversing the plain of the Saphyrs, where 4000 Burmese are employed in the search for precious stones. After visiting the ruins of Angkor, he reached Saigon on June 12 last.

THE oldest Geographical Society in Europe has hitherto been regarded as that of Paris, founded in 1821, but according to a paper recently read before the Verein für Erdkunde at Dresden by Dr. Ruge, this honour belongs to the "Cosmographic Society" of Nuremberg. It was established about 1740, and first came before the public in 1746, and was connected with Homann's establishment in Nuremberg. The founder of the latter was the well-known cartographer, Johann Homann, on

whose death in 1724 it descended to his son. The latter, having died childless, gave the business to a relative named Ebersberger, and a friend named Franz, provided they always retained the name of Homann in the title of the firm. Franz endeavoured to introduce originality into their maps, thus coming in contact with many geographers, and ultimately founding the "Cosmographic Society," which was divided into mathematical, geographical, and historical sections. In a work published in 1750—the "Kosmographische Nachricht und Sammlung auf das Jahr 1748"—the Society complained loudly of the defective condition of mapping and surveys in the German States, and criticised unfavourably existing maps of Germany, as well as suggested the best modes of improving them. The paper then describes the principal members of the Society, their projects for the increase of geographical knowledge—among others a lottery to procure funds. Gradually, however, the leading spirits were called away to various German universities, or to Russia; the Seven Years' War prevented any steady work of the kind advocated; Franz and Tobias Meyer died, and the "Cosmographic Society" ceased. Its labours appear to have been confined to remedying defects which lay at hand, to supplying good popular maps of Germany, and to obtaining more accurate information as to German geography.

In August last the ship *Fenorina*, Capt. Nilson, arrived at Philadelphia from Ivigtut, in Greenland, reporting that an Eskimo had found on an ice-floe in the Julianehaab Bay, the lower part of a tent, the sides of a wooden chest, and some other things marked *Jeannette*, a bill of lading, and some cheques signed "De Long," a pair of oilskin trousers marked "Louis Noros," and a bearskin which covered something of the shape and size of a human body, but which the Eskimo did not examine on account of his superstitious prejudices. On another floe he found a quantity of sailors' apparel. The Eskimo brought some of the articles to Julianehaab, and gave them to the governor, Herr Lytzen, who at once set out to recover all the rest, but the Eskimo was unable to find the spot again. Herr Lytzen now states that among the articles are two sides of a wooden chest, on which is written in pencil, "General orders, telegrams, sailing orders, discipline, ship's papers, various papers, various agreements, charter party, . . ." The last words are not very clear. On the other board is written, "Before sailing." There is also a torn book of cheques, on which is printed, "For deposit with the Bank of California," and a pair of oilskin trousers marked "Louis Noros." The most remarkable circumstance of this discovery is naturally the spot in which it was made, as these articles must in the course of three years have drifted on an ice-floe from long. 155° E. to 46° W.! They can hardly hail from the place where the *Jeannette* was crushed, as she sank, and the surrounding ice-floes were ground to dust by the catastrophe. But we know from the reports of Messrs. Dannenhower and Melville that the crew, after leaving the vessel, camped for a few days on some ice-floes, in order to divide the provisions. This took place near the New Siberian Islands, and probably the tent had been erected where the remains were now found. As nobody had then died, there cannot have been any corpse under the bearskin. Which way the ice-floe has drifted can only be conjectured; but by a rough calculation the distance is about 2500 nautical miles, and, as it has been covered in about 1000 days, the average rate of drifting is 2½ nautical miles per day, without allowing for deviations.

"Emperor William," "Prince Bismarck," and "Count Moltke" are the names given to three cataracts by Herr Gustav Mederstein on his exploring tour up the Parana River in the province of Misiones (Argentine Republic). They belong to a middle group of some hundred cataracts of the Iguassi River, which at that spot forms the boundary between the Argentine Republic and Brazil. The river's breadth above the falls is about 5 kilometres; the "Emperor William" is the middle one of the three cataracts, and the total height of the falls is about 50 metres. At a distance of some 16 kilometres below the falls the Iguassi joins the Parana.

M. Thouar, who has already travelled in South America in search of the Crevaux Expedition, is about to commence a new journey of exploration, which is to last two or three years. He intends investigating the delta of the Pilcomayo, and endeavouring to open a great trade route between Bolivia and Paraguay. In this work he will, it is said, receive the active support of several South American Governments. During the journey he will collect the materials for a great work on South America.

The Expedition which had left Loango, led by Lieut. Delizie, in order to carry provisions to De Brazza's Mission at Stanley Pool, was abandoned by about two hundred carriers on the shore of Lake Loudima. It arrived at the Manyanga Station on the Congo (a station of the International Society) on July 18, and prepared to make a new start.

AN ACCOUNT OF SOME PRELIMINARY EXPERIMENTS WITH BIRAM'S ANEMOMETERS ATTACHED TO KITE STRINGS OR WIRES[1]

These experiments were regularly commenced in September 1883, and continued at intervals up to June 14, 1884. A preliminary note descriptive of the apparatus and method employed appeared in the *Quarterly Journal* of the Royal Meteorological Society in 1883. As, however, some improvements have since then been made in the mode of flying and estimating the heights, it may be as well to give a brief account of the scheme *de novo*.

First of all two kites are now flown tandem, the upper one being a small kite about 4 feet high, which is easily got up, and which, when it has reached an altitude of about 100 feet, where the wind is always considerably stronger than at the earth's surface, is used to lift up the larger main kite (7 feet high) which bears the string (latterly wire) to which the instruments are fastened. It also helps to keep the latter steady when up, and prevent any sudden and dangerous descent of kites and instruments. The larger kite is now made of tussore silk of the diamond pattern and capable of folding up like Archer's patent portable kites. The tail, which is in reality a most important adjunct, and usually the first part of the apparatus to give way, is made of six large wire-rimmed canvas cones fastened to a swivel which allows them to revolve without twisting their cord.

In the first experiments the main kite was flown with a strong flax cord, but latterly, at a suggestion by Sir William Thomson, piano-cord steel wire has been used similar to that employed in Sir William's deep-sea sounder. This I have found a great improvement on the string. It is double the strength, one-fourth the weight, one-tenth the section, and one-half the cost, the only drawback being that, unless great care be exercised, it is very liable to kink and rust. To obviate the latter I have got my supply for the coming year electroplated.

It is also necessary to have wire all through, otherwise a disagreeable discharge of electricity is apt to take place at the junction of the wire and string in ordinary weather, a fact to which some of my friends would be able to testify. When the wire is continuous, and in contact with the iron of the winder which is riveted to the ground, I have found no perceptible shock in ordinary weather. The winder was made for me by Messrs. Elliott Bros., and though by no means perfect, is capable of being riveted to the earth so as to hold the kite in a powerful wind, and being furnished with a ratchet and spring catch, can be locked so as to allow me to attend to the anemometers, take observations with the theodolite, &c.

The anemometers are of the ordinary Biram pattern, 6 inches in diameter, and suspended to a gun-metal rod so as to swing in the vertical plane of the wire, the rod being fastened to the wire by clamps at its ends. When the large kite is about 100 feet or so from the winder, and steady, an anemometer is fastened to the nearest 100-foot mark and its indication and the time noted. The wire is then payed out a certain distance, and another anemometer attached, and so on, the interval between the lowest instrument and the winder being regulated by whether the differences of velocity are required for a comparatively high or low altitude respectively. The altitudes are measured by taking the vertical angles of the instruments every ten minutes with a theodolite placed at the winder, and combining their average value for the whole period with the lengths up to each instrument. The method employed is necessarily approximate, as I cannot leave the winder very well and take simultaneous observations at the ends of a base line. It is, however, one which I have reason to believe to be very fairly accurate. A certain allowance for curvature is made up to the lowest instrument. The arc between the two instruments is then taken to be approximately equal to its chord, and from this and the vertical angles the chord to the highest instrument is calculated, and thence its vertical height. This method

[1] Paper read at the Montreal meeting of the British Association by Prof. E. Douglas Archibald.

has occasionally been checked by observations taken at the ends of a base of 891 feet, and with such satisfactory results, that in the present case, where the observations being relative, great accuracy in measuring the absolute heights is not required, I have decided to adopt it in preference to the latter infinitely more cumbrous method.

Numerous observations have been made without success, accidents of all kinds happening both to kites and instruments, sufficient to deter any one who was not imbued with a little faith that all would eventually come right. I have therefore only been able so far to collect the results of a select few, viz. 23 in all, in which the conditions were favourable.

Hitherto I have only used kites as a *point d'appui* for observations on the differential velocity of the air at different heights, a purpose for which they are obviously exceptionally fitted. I am hoping, however, during the coming year, with new and improved apparatus and assistance, for which I have received a Government grant, to employ the same means of elevation for observations of temperature, pressure, height of cloud-strata, &c.

Anemometer Observations on Kite-Wire

Date and time of day	Instrument	Height in feet H	Velocity in feet per minute V	Time in minutes T	True direction of wind D
1883					
Sept. 8	B	278	1561	98	N. 22° W.
4.53 p.m.	A	77	989	82	
Sept. 10	A	257	1542	106	S. 8° E.
12.25 p.m.	B	160	1352	85	
Oct. 6	B	425	1177	121	N. 7° E.
3.59 p.m.	A	178	833	109	
Oct. 20	B	380	1163	75	N. 85° W.
3.29 p.m.	A	146	882	59	
Oct. 20	A	217	1209	34	N. 85° W.
5.12 p.m.	B	98	864	25	
Oct. 24	B	230	1907	25	S. 82° W.
4.12 p.m.	A	110	1248	19	
Nov. 10	A	383	1771	130	N. 48° W.
12.31 p.m.	B	138	1499	109	
Nov. 10	B	405	1791	114	N. 75° W.
3.1 p.m.	A	148	1539	102	
1884					
Feb. 16	A	232	2079	26	S. 38° E.
4.42 p.m.	B	107	1638	20	
Feb. 23	B	430	2534	90	S. 37° W.
4.31 p.m.	A	294	2441	85	
Feb. 27	A	130	1147	56	S. 53° E.
5.26 p.m.	B	40	746	45	
March 8	B	270	1392	73	S. 49° W.
5.13 p.m.	A	88	1012	37	
March 15	B	268	1632	103	S. 48° E.
4.50 p.m.	A	79	1119	89	
March 19	A	433	1518	62	S. 52° W.
4.44 p.m.	B	215	1234	53	
March 20	B	344	2384	79	S. 87° W.
3 14 p.m.	A	167	2016	66	
April 2	A	446	1639	78	S. 23° E.
5.49 p.m.	B	212	1165	68	
April 4	B	430	2202	101	S. 44° E.
3.34 p.m.	A	228	1916	79	
May 14	D	422	2038	112	S. 38° W.
3.13 p.m.	C	292	1936	99	
	B	185	1904	90	
May 26	B	495	1994	69	N. 77° E.
2.58 p.m.	D	207	1879	59	
May 29	D	646	1769	98	S. 64° E.
3.44 p.m.	B	310	1648	90	
May 30	B	631	2102	97	N. 37° E.
3.38 p.m.	D	329	2025	88	
May 30	D	643	2039	87	N. 35° E.
5 p.m.	B	334	1987	78	
June 14	A	618	2040	52	N. 1° E.
11.5 a.m.	C	324	1950	38	

The height of the place of observation is 500 feet above sea-level.

Of course it is not intended at this early stage to attempt to draw any but the most temporary conclusions from such sparse data. There is no doubt that if observations could be taken every hour a distinct diurnal variation in the difference between the velocity at two given heights would be obse ved, the velocity at the greater altitude probably tending towards a minimum about the same time that the velocity at the earth's surface reached its maximum. This would, however, only be found to be the case when the heights were about 1000 feet or more. Apart from actual determination by help of the instruments, however, the existence of such a diurnal variation has been several times forcibly brought to my notice by the fact that while during the middle of the day the kite frequently flies with great difficulty owing to the presence of vertical ascending and descending currents; towards evening, when the wind at the surface has often died away altogether, the kite flies at a higher altitude and pulls harder and steadier than it did during the day. This has so often occurred that I have ceased noting it as anything extraordinary. I may observe that such a condition is precisely what one would expect if the theory of the diurnal variation in the velocity of the surface wind given by Dr. Köppen in the *Zeitschrift der Oesterreichschen Gesellschaft für Meteorologie* for 1879, be accepted. According to this theory the expansion of the lower strata by solar action during the day, causes an intermixture of the air (*'uft austausch*) to take place between the upper and lower layers, by which the velocity of the lower layers is increased by the greater velocity which the descending air brings with it from above, while the upper layers have their velocity decreased by the smaller velocity with which the ascending lower air retarded by the asperities of the earth's surface, is endowed. Thus while the mean velocity of the atmosphere might remain about the same, the differences between the velocities above and below should undergo a diurnal period, the minimum difference occurring somewhat after midday. I was glad to see the other day that some observations on the velocity of the wind at some lofty observatory (I think Pike's Peak) showed that the diurnal period in the wind velocity at 8000 or 9000 feet, in exact opposition to what occurs at the earth's surface, exhibited a *minimum* about midday.[1]

Another feature that has been brought out by observing the flight of my kites, which frequently fly at heights of from 1300 to 1500 feet above the sea and thus enter the clouds, is the existence of a *courant ascendant* under cumulus and cumulo-stratus clouds. When such a cloud comes over, the kite rises up until the string is at an angle of 60° or more; but in proportion as it rises, so its pull becomes weak; the kite in fact lies on its face, and thus losing nearly all the horizontal component, the curvature of the string increases very much, and if an instrument is attached to it, it is sure to come down. After such a cloud has passed I have frequently noticed the apparent existence of a downward current which causes the kite to descend and at the same time increase its pull by the pressure being exerted more against a vertical surface.

Regarding the observations themselves, I am not aware that any similar ones have previously been made, except by Mr. Stevenson of Scotland. His plan was to fix anemometers to a pole 50 feet high or place them at different heights up a mountain. In the latter case it is not certain that the velocities represent what would occur in the free atmosphere at the same level. In the former, one is limited to poles of moderate height, and I do not at present see that anything else can compete with a kite-wire for greater heights; balloons, captive or otherwise, being of course out of the question where wind is concerned. Mr. Stevenson seems finally to have adopted a very simple formula for the increase of the velocity with the height, viz. that it is exactly prop rtional, or $\frac{V}{v} = \frac{H}{h}$. That though this might be true up to 50 feet it is certainly not true for greater heights I showed pretty conclusively in NATURE for March 29, 1883 (p. 506), where a discus ion of Dr. Vettin's cloud observations favoured the formula $\frac{V}{v} = \left(\frac{H}{h}\right)^{\frac{1}{4}}$ through a range of mo e than 20,000 feet.

Though I do not wish to try and determine any formula at this preliminary stage, it may be interesting to note the exponent

[1] This seems also to be the case on Ben Nevis, regarding which Mr. Buchan says, "In each of the months the maximum velocity is during the *night*, and the minimum during the *day*, being thus the reverse of what occurs at low levels and on plains" (*vide Journal* of the Scottish Meteorological Society, 3rd series, No. 1, p. 17).

yielded by the observations I have made, when grouped together roughly according to altitude. The results are :—

No. of obs.		Mean upper height		Mean lower height		Mean upper velocity		Mean lower velocity		Approximate value of exponent in formula
6	...	249	...	93	...	1630	...	1145	...	$\frac{1}{3}$
8	...	412	...	173	...	1751	...	1474	...	$\frac{1}{5}$
4	...	634	...	324	...	1987	...	1902	...	$\frac{1}{10}$

Thus, while the velocity invariably increases as we ascend, the rate rapidly diminishes after the first 200 or 300 feet. It must, however, be remembered that the place of observation is itself 500 feet above sea-level, and though this would probably not affect the results near the surface, the air above 200 feet must be moving with very nearly the same velocity as it would have at its real elevation above a sea-level surface. Adding therefore the 500 feet to both heights in the case of the two last groups, we get, for the value of x, $\frac{1}{2}$ and $\frac{1}{7}$ instead of $\frac{1}{5}$ and $\frac{1}{10}$. These two values are probably nearer the truth than those in the table, and hover round the mean value $\frac{1}{4}$, which I have already stated was found to hold for Vettin's cloud velocities up to 25,000 feet. In any case it is plain that Mr. Stevenson's formula cannot be taken to hold beyond his 50-foot pole.

Further observations will, I trust, give a trustworthy basis for determining the variations in the velocity-increment corresponding to the direction and absolute velocity of the wind as well as those corresponding to season, humidity, temperature, and pressure. To thoroughly investigate the velocity-increment under all such conditions, and thus to afford data to the physicist who desires to construct the hitherto unwritten science of aërodynamics, will be one of the objects of my experiments during the coming year.

P.S. *October* 22.—Since the foregoing observations were made I have succeeded in getting readings with the anemometers at heights of over 1100 feet above the ground, or 1600 feet above sea-level.

THE CLASSIFICATION AND AFFINITIES OF DINOSAURIAN REPTILES[1]

IN this paper the author presented briefly the results of a study of Dinosaurian reptiles on which he had been engaged for several years. The complete results will be published in a series of monographs now in preparation. The material on which the investigation is mainly based consists of the remains of several hundred individuals of this group collected in the Rocky Mountains by the author, and now preserved in the museum of Yale College. Other important American specimens have been examined by the author, who has also studied with care the more important specimens of this group in the museums of Europe. The investigation is not yet completed, but the results already attained seem to be of sufficient interest to present to the Association at this time.

In previous publications on this subject the author had expressed the opinion that the *Dinosauria* should be regarded, not as an order, but as a sub-class, and his later researches confirm this view. The great number of subordinate divisions in the group, and the remarkable diversity among those already discovered, indicate that many new forms will yet be found. Among those already known there is a much greater difference in size and structure than in any other sub-class of vertebrates, with the exception of the placental mammals. Compared with the Marsupials, living and extinct, the *Dinosauria* show an equal diversity of structure and size.

According to present evidence, the Dinosaurs were confined entirely to the Mesozoic Age. They were abundant in the Jurassic, and continued in diminishing numbers to the end of the Cretaceous period, when they became extinct. The great variety of forms that flourished in the Triassic renders it more than probable that some members of the group existed in the Permian period, and their remains may be brought to light at any time. The Triassic Dinosaurs, although very numerous, are known to-day mainly from footprints and fragmentary osseous remains; hence, many of the forms described cannot at present be referred to their appropriate divisions in the group. From the Jurassic, however, during which period Dinosaurian reptiles reached their zenith in size and numbers, representatives of no less than four well-marked orders are now so well known that different families and genera can be very accurately determined, and almost the entire osseous structure of typical examples, at least, can be made out with certainty. Comparatively little is yet known of Cretaceous Dinosaurs, although many have been described from incomplete specimens. All these appear to have been of large size, but much inferior in this respect to the gigantic forms of the previous period. The remains best preserved show that, before extinction, some members of the group became quite highly specialised.

Regarding the Dinosaurs as a sub-class of the REPTILIA, the forms best known at present may be classified as follows :—

SUB-CLASS DINOSAURIA.—Premaxillary bones separate; upper and lower temporal arches; rami of lower jaw united in front by cartilage only; no teeth on palate. Neural arches of vertebræ united to centra by suture; sacral vertebræ co-ossified. Cervical and thoracic ribs double-headed. Ilium prolonged in front of acetabulum; acetabulum formed in part by pubis; ischia meet distally on median line. Fore and hind limbs present, the latter ambulatory and larger than those in front; head of femur at right angles to condyles; tibia with procnemial crest; fibula complete. First row of tarsals composed of astragalus and calcaneum only, which together form the upper portion of ankle joint.

(I.) Order SAUROPODA (LIZARD-FOOT).—Herbivorous. Premaxillary bones with teeth. Large antorbital opening. Anterior nares at apex of skull. Post-occipital bones. Anterior vertebræ opisthocœlian; cervical ribs co-ossified with vertebræ; pre-sacral vertebræ hollow; each sacral vertebra supports its own transverse process. Fore and hind limbs nearly equal; limb bones solid. Feet plantigrade, ungulate; five digits in manus and pes; second row of carpal and tarsal bones unossified. Sternal bones parial. Pubes projecting in front, and united distally by cartilage; no post-pubis.

(1) Family *Atlantosauridæ*.—A pituitary canal. Ischia directed downward, with expanded extremities meeting on median line. Sacrum hollow. Anterior caudals with lateral cavities. Genera: Atlantosaurus, Apatosaurus, Brontosaurus.

(2) Family *Diplodocidæ*.—Dentition weak. Brain inclined backward. Large pituitary fossa. Two antorbital openings. Ischia with straight shaft, not expanded distally, directed downward and backward, with ends meeting on median line. Caudals deeply excavated below. Chevrons with both anterior and posterior branches. Genus: Diplodocus.

(3) Family *Morosauridæ*.—Small pituitary fossa. Ischia slender, with twisted shaft, directed backward, and sides meeting on median line. Anterior caudals solid. Sacral vertebræ solid. Genus: Morosaurus. European forms of this order: Bothriospondylus, Ceteosaurus, Eucamerotus, Ornithopsis, Pelorosaurus.

(II.) Order STEGOSAURIA (PLATED LIZARD).—Herbivorous. Feet plantigrade, ungulate; five digits in manus and pes; second row of carpals unossified. Pubes projecting free in front; post-pubis present. Fore limbs small; locomotion mainly on hind limbs. Cervical ribs free. Vertebræ and limb bones solid. Osseous dermal armour.

(1) Family *Stegosauridæ*.—Vertebræ bi-concave. Neural canal in sacrum expanded into large chamber; ischia directed backward, with sides meeting on median line. Astragalus co-ossified with tibia; metapodials very short. Genera: Stegosaurus (Hypsirhophus), Diracodon; and in Europe, Omosaurus (Owen).

2. Family *Scelidosauridæ*.—Astragalus not co-ossified with tibia; metatarsals elongated; four functional digits in pes. Known forms all European. Genera: Scelidosaurus, Acanthopholis, Cratæomus, Hylæosaurus, Polacanthus.

(III.) Order ORNITHOPODA (BIRD-FOOT).—Herbivorous. Feet digitigrade, five functional digits in manus and three in pes. Pubes projecting free in front; post-pubis present. Vertebræ solid. Cervical ribs free. Fore limbs small; limb bones hollow. Premaxillaries edentulous in front. A premandibular bone.

(1) Family *Camptonotidæ*.—Clavicles wanting; post-pubis complete. Genera: Camptonotus, Laosaurus, Nanosaurus; and in Europe, Hypsilophodon.

(2) Family *Iguanodontidæ*.—Post-pubis incomplete. Premaxillaries edentulous. Known forms all European. Genera: Iguanodon, Vectisaurus.

[1] Paper read at the Montreal Meeting of the British Association, by Prof. O. C. Marsh.

(3) Family *Hadrosauridæ.*—Teeth in several rows, forming with use a tesselated grinding surface. Anterior vertebræ opisthocœlian. Genera: Hadrosaurus (Diconius ?), Agathaumas, Cionodon.

(IV.) Order THEROPODA (BEAST-FOOT).—Carnivorous. Premaxillary bones with teeth. Anterior nares at end of skull. Large antorbital opening. Vertebræ more or less hollow. Feet digitigrade; digits with prehensile claws. Pubes projecting downward, with distal ends co-ossified.

(1) Family *Megalosauridæ.*—Anterior vertebræ convexo-concave; remaining vertebræ bi-concave. Pubes slender. Astragalus with ascending process. Genera: Megalosaurus (Poikilopleuron), Allosaurus, Cœlosaurus, Creosaurus, Dryptosaurus (Lælops).

(2) Family *Labrosauridæ.*—Lower jaws edentulous in front. Cervical and dorsal vertebræ convexo-concave. Pubes slender, with anterior margins united. Astragalus with ascending process. Genus: Labrosaurus.

(3) Family *Zanclodontidæ.* — Vertebræ bi-concave. Pubes broad elongate plates, with anterior margins united. Astragalus without ascending process. Five digits in manus and pes. Genera: Zanclodon (?), Teratosaurus.

(4) Family *Amphisauridæ.*—Vertebræ bi-concave. Pubes rod-like. Five digits in manus, and three in pes. Genera: Amphisaurus (Megadactylus ?), Bathygnathus (?), Clepsysaurus, Palæosaurus, Thecodontosaurus.

(*a*) Sub-order CŒLURIA.—(5) Family *Cœluridæ.*—Vertebræ and bones of skeleton pneumatic. Anterior cervicals convexo-concave; remaining vertebræ bi-concave. Cervical ribs co-ossified with vertebræ. Metatarsals very long and slender. Genus: Cœlurus.

(*b*) Sub-order COMPSOGNATHA.—(6) Family *Compsognathidæ.*—Cervical vertebræ convexo-concave; remaining vertebræ bi-concave. Three functional digits in manus and pes. Ischia with long symphisis on median line. Genus: Compsognathus.

(*c*) Sub-order CERASTOSAURIA.—(7) Family *Ceratosauridæ.*—Horn on skull. Cervical vertebræ plano-concave; remaining vertebræ bi-concave. Pubes slender. Pelvic bones co-ossified. Osseous dermal plates. Astragalus with ascending process. Metatarsals co-ossified. Genus: Ceratosaurus.

The four orders defined above, which the author first established for the reception of the American Jurassic Dinosaurs, appear to be all natural groups, well marked in general from each other. The European Dinosaurs from deposits of corresponding age fall readily into the same divisions, and, in some cases, admirably supplement the series indicated by the American forms. The more important remains from other formations in this country and in Europe, so far as their characters have been made out, may likewise be referred with certainty to the same orders.

The three orders of herbivorous Dinosaurs, although widely different in their typical forms, show indications of approximation in some of their aberrant genera. The *Sauropoda* for example, with *Atlantosaurus* and *Brontosaurus*, of gigantic size, for their most characteristic members, have in *Morosaurus* a branch leading towards the *Stegosauria*. The latter order, likewise, although its type genus represents in many respects the most strongly marked division of the Dinosaurs, has in *Scelidosaurus* a form with some features pointing strongly toward the *Ornithopoda*.

The carnivorous *Dinosauria* now best known may all be placed at present in a single order, and this is widely separated from those that include the herbivorous forms. The three sub-orders here defined include very aberrant forms, which show many points of resemblance to Mesozoic birds. Among the more fragmentary remains belonging to this order, this resemblance appears to be carried much farther.

The *Amphisauridæ* and the *Zanclodontidæ*, the most generalised families of the *Dinosauria*, are known only from the Trias. The typical genera, however, of all the orders and sub-orders, are Jurassic forms, and on these especially the present classification is based. The *Hadrosauridæ* are the only family confined to the Cretaceous. Above this formation there appears to be at present no satisfactory evidence of any *Dinosauria*.

The peculiar orders *Hallopoda* and *Aetosauria* include carnivorous reptiles which are allied to the *Dinosauria*, but they differ from that group in some of its most characteristic features. In both *Aetosaurus* and *Hallopus* the calcaneum is much produced backwards. In the former genus the entire limbs are crocodilian, and this is also true of the dermal covering. In both of these genera there are but two sacral vertebræ, but this may be the case in true Dinosaurs, especially from the Trias. Future discoveries will probably bring to light intermediate forms between these orders and the typical Dinosaurs. The *Crocodilia* have some some strong affinities with the *Dinosauria*, especially with those of the order *Sauropoda*. The extinct genus *Belodon* of the Triassic, for example, resembles *Diplodocus*, particularly in the large antorbital vacuities of the skull, the posterior position of the external nasal aperture, as well as in other features. The *Rhynchocephala*, represented by the genus *Hatteria*, have several important characters in common with the *Dinosauria*, and, as the former is evidently an ancient type, it is probable that a real affinity may exist between these two groups.

That birds are closely related to Dinosaurs there is no longer any question. In addition to the various characters which these groups have been known to share with each other, two more may be added in consequence of discoveries made during the past year. The genus *Ceratosaurus*, a carnivorous Dinosaur from the Jurassic of the Rocky Mountains, recently described by the author, has the pelvic bones co-ossified, as in all known birds, living and extinct, except *Archæopteryx*. The same reptile, moreover, has the metatarsal bones firmly united, as in all adult birds, with possibly the single exception of *Archæopteryx*, while all the known *Dinosauria*, except *Ceratosaurus*, have both the pelvic and the metatarsal bones separate. The exception in each case brings birds and reptiles near together at this point, and their close affinity is now a matter of demonstration.

THE DANISH EXPEDITION IN GREENLAND

WE have on previous occasions referred to the Expedition under Lieuts. Holm and Garde, which has for more than a year been engaged in exploring the east coast of Greenland, and we are now able to supplement this with an interesting report from Lieut. Holm, written in the spring, from the winter quarters of the Expedition, and received some time ago by sailing-vessel at Copenhagen.

The place where the Expedition wintered is called Namortalik, and lies on the east coast, about fifty miles, as the crow flies, from Cape Farewell. It is also called Björneorten (the "bear-haunt"), from the many bears in the neighbourhood. After an excursion lasting two months and a half during the summer of 1883, the Expedition returned in September to Namortalik, but the huts for wintering not being finished, they started for a week's further excursion to the Fredriksdalsfjord, between Namortalik and Cape Farewell.

It was not until the end of October that the Expedition could begin their regular scientific observations at the station, but after that date they were continued without interruption through the winter. As, however, the chief object of the Expedition was to explore the east coast in boats, the scientific observations have not been so rich as those, for instance, of the Danish International Expedition at Godthaab in 1882-83 (NATURE, vol. xxix. p. 337); but every effort was made to adhere as strictly as possible to the programme of the International Polar Commission. The meteorological observations were made every third hour from 8 p.m. to 8 a.m., and the magnetic observations every hour except at 3 and 4 a.m. On the 1st and 5th of every month the magnetic instruments were read every fifth minute during eight hours and every twentieth second during one hour.

With reference to the climatological conditions of the east coast, we learn that the winter is very raw and severe, although it cannot be said to be of excessive duration. The pleasant, calm, frosty weather which is experienced in North Greenland seldom prevails on the east coast, but in its stead there are frequent and sudden changes and violent storms; there being, for instance, one day 20° C. of frost, and the next several degrees of heat, while heavy rains and snows alternate. In consequence of these sudden changes it is impossible in East Greenland to employ the mode of locomotion so valuable in other parts, viz. the dog-sledge. The only means of conveyance here is by boat. If, therefore, the sea is frozen over for a time, the inhabitants remain where they are, and wait patiently until a higher temperature removes the obstacle. The ice never becomes firm enough to bear a man and sledge.

Up to January last the temperature had not fallen lower than 15°·5 C.—about Christmas—the glass generally standing between

4° and 6°, and even on some days not lower than zero (= 32° F.). This was particularly the case whilst the north-east "Föhn" wind prevailed, to which East Greenland is indebted for its comparatively mild winters; but there are places where the ice lies firm throughout the winter. On December 5, during a "Föhn" wind, the thermometer rose to + 10° C. After the beginning of the new year, however, the cold became more severe, and the "Föhn" winds less frequent.

Towards the end of January and in February the thermometer sometimes registered 20° C. of frost, and on March 9 it fell to − 21°·5, the lowest temperature registered during the winter.

Some interesting particulars are also given of the almost unknown district in which the Expedition wintered. The station Namortalik is described as situated on an island, and as having a population of 250 souls. The island, which bears the same name, is surrounded by several others, which, lying further out to sea, are visited during the spring by the natives, who catch seals and eider-ducks there. To the north the scenery of Greenland is seen in all its grandeur and beauty; wild mountains with lofty cones rising above the clouds. These are on the beautiful but almost unapproachable island of Sermerok. If the air be clear, and the weather calm and sunny, the little island lies so peacefully in the ocean that one feels tempted to climb the lofty mountains; but when the storm hovers around the peaks, half hidden in drifting clouds, and the Polar Sea is a mass of foam, the giant forms of the mountains deter even the boldest. The mainland is rugged, like the island just mentioned; in fact, the whole southern portion of Greenland is a region of wild mountains, furrowed by tremendous ravines, and rising to a height of nearly 8000 feet, from which enormous glaciers descend to the sea. The landscape produces by its wildness and desolation very striking impressions.

There are thirty little turf-covered houses at Namortalik, including a bakery and a brewery. The so-called "Royal Commerce of Greenland," a Danish Company, has also a depot here. There is, besides, a Lutheran mission, a church, and a school attended by half-caste Greenlanders.

The Expedition has erected two observatories on the rocks, about 1000 feet from the dwelling-houses, but connected by telephone.

Close to Namortalik is the Tasermint Fjord, some fifty miles in length, one of the loveliest in South Greenland. On its shores the vegetation is very luxuriant in summer, and the heat and mosquitoes are so troublesome that one could imagine one's self in the tropics. This fjord is of great importance to the Namortalik people, as its shores provide them with fuel, its streams and waters with salmon, seals, and herrings, and its mountain-slopes with ptarmigans, Polar hares, and foxes.

When the summer commenced, the Expedition intended to leave their quarters, and continue the exploration of the east coast; but there is at present no news of their achievements this summer. The programme is, however, to explore the east coast by sea and land as far north as possible, and to get into communication with the natives whenever opportunity offers, in which latter attempt nearly all previous Expeditions have been disappointed.

At the beginning of this winter one half of the Expedition was to return to Namortalik, while the second endeavoured to spend the winter as far north as possible. The Expedition will leave Greenland in the autumn of next year.

SCIENTIFIC SERIALS

Journal of Botany, August to November.—The most important article in the recent numbers of this magazine is Mr. Charles Bailey's paper on the structure, &c., of *Naias graminea*, Delile, var. *Delilei*, Magnus, illustrated with four plates and many woodcuts. This interesting addition to the British flora—first found in 1883 in a canal in Lancashire—is a native of warmer climates, not being indigenous anywhere in Europe, and has probably been introduced with Egyptian cotton. Mr. Bailey gives an exhaustive account of the morphology of its various organs, and especially of its mode of fertilisation. The *Naias* belongs to a class of plants that may be called "protozoophilous," the pollen being carried to the stigma by aquatic animals of low organisation, in this instance by the currents caused by the rotating cilia of species of Vorticellidæ.—Most of the other articles in these numbers are of more limited interest, being topographical papers on the flowering plants or cryptogams of particular districts, or descriptions of new or little-known species.—Additional instalments are also given of Mr. J. G. Baker's synopsis of the genus *Selaginella*, which is still uncompleted, the species now described amounting to 180.

Nuovo Giornale Botanico Italiano, July to October.—The greater part of the space in the July number of this magazine is occupied by descriptive papers. The paper of most general interest is that by A. Piccone, on the algæ of the Red Sea. He shows that the algal flora of this sea shows much closer affinities to that of the Indian Ocean than of the Mediterranean. It is characterised by the small number of diatoms and of green algæ generally, by the entire absence of Laminarieæ, and, above all, by its extraordinary richness in species of *Sargassum*, many of them endemic.—In the October number are a synopsis of the flora of Sicily, and a list of the "pronubi" or insect-fertilisers of flowering plants in Calabria and Piedmont; also a note by R. Pirotta, showing, from an examination of the oospores, the identity of *Cystopus capparidis*, parasitic on the caper, with *Cystopus candidus*, the common parasite of cruciferous plants.

SOCIETIES AND ACADEMIES

London

Linnean Society, November 6.—Sir J. Lubbock, Bart., President, in the chair.—A letter was read intimating that their late President, Mr. G. Bentham, had bequeathed in his will a legacy of 1000*l*. to the Society.—A notice of invitation for the Fellows to attend the centenary (December 4) of the Royal Bohemian Society of Natural History in Prague was also read from the chair.—Mr. W. T. Thiselton Dyer exhibited the following plants and their products:—(1) *Vaccinium arctostaphylus*, from which the Trebizonde tea ("Thé-du-Bu-Dagh") is prepared at Amassia and Tokat. The tea has a pleasant odour, but a somewhat harsh taste when drunk. (2) *Pueraria Thunbergiana*, specimens of this Corean plant and of the cloth made from it. (3) *Pachyrhyza sinensis*, with the native name of "Ko-poo," a leguminous plant from the fibres of which the yellow and more expensive summer cloth is made.—Mr. Thos. Christy showed and made remarks on a specimen of *Kola acuminata*.—Mr. R. A. Rolfe afterwards exhibited examples of British oak-galls produced by Cynipidean insects of the genus *Neuroterus*. These were the silk-button gall formed by *N. numismatis*, the globose gall produced by *N. ostreus*, the smooth-spangle gall formed by *N. fumipennis*, the scarce-spangle gall formed by *N. læviusculus*, and the common spangle gall produced by *N. lenticularis*, as also a purple variety of the latter gall. He stated that the plan and details of the galls depend on the nature of the irritating fluid deposited by the insect; but on the other hand the different species of oak seem to have an influence in determining certain variations as to colour, and, it may be, general growth, of the galls.—Mr. Geo. Brook read a paper on the development of the Five-bearded Rockling (*Motella mustela*) in which the following points were enunciated:—(1) Whereas there is only one large oil globule in the normal egg of *Motella*, sometimes this is subdivided into from two to eight or even more; but in these cases there is always an abnormal development which often results in the death of the embryo. In those that survive, the small oil globules always coalesce to form one large one before the embryo hatches. (2) In the further development of the newly-hatched embryo there is a cranial flexure produced which is analogous to that so characteristic of Elasmobranchs. This is caused by the rapid development of the dorsal portion of the head, while the ventral portion remains comparatively quiescent. Later, the ventral portion plays its part, and, with the development of the jaws the brain is pushed back to its normal position. (3) As in other pelagic Teleostean eggs, there is no circulation observable either in the embryo or in the vitellus up to the time of hatching, nor indeed for some days afterwards. (4) In *Motella* the anal gut does not open on the ventral surface for at least a week after hatching. Ryder has shown the same to be the case with the cod-fish, so that the young *Gadidæ* would not appear to be in a position to take solid food at nearly so early a period in their existence as is usual with Teleosteans. Mr. Brook also called attention to the influence of temperature on the rate of development of pelagic eggs, and suggested that, until we know the temperature at which the various observations are made on these forms, no true comparison can be established.—The next communication was on a collection of

plants made in Timor Laut by Henry O. Forbes. Therein a short account is given of the nature of the islands and of the general character of the vegetation, after which comes a technical list of about eighty plants.—Prof. Oliver adds a note that, "This collection, so far as it goes, is made up in great part of the more widely diffused species of the Indian Archipelago. The most interesting plants appear to be: one in fruit only, referred to the meliaceous genus *Owenia*, probably *O. cerasifera*, Muell., of Queensland; a fine *Mucuna*, of the section Stigolobium; a *Selarbrea*, an araliaceous genus hitherto only received from New Caledonia, and a fruit of possibly a *Strombosia*. Mr. Forbes himself is inclined to regard the Timor Laut flora and fauna as having affinities with the Moluccan (Amboina) region.—A paper by T. H. Potts was read, containing notes on some New Zealand birds. This consisted chiefly of field observations on the habits of the quail hawk, harrier, owl, kaka, kea, long-tailed cuckoo, kingfisher, and native wren.—There followed a note on the reproduction of the heterœcismal Uredines by Charles B. Plowright. Therein the author affirms that, when the reproduction of these fungi takes place without the intervention of Ascidiospores, the resulting Uredospores are far more abundant than in the case when they arise from the implantation upon the host plant of the Ascidiospores, this inference being supported by various detailed observations of the author.

Zoological Society, November 4.—Prof. W. H. Flower, F.R.S., President, in the chair.—Mr. Sclater exhibited and made remarks on the skin of a Woolly Cheetah (*Felis lanea*), obtained at Beaufort West, South Africa, sent to him by the Rev. G. H. R. Fisk, C.M.Z.S.—The Secretary exhibited, on behalf of Major W. Brydon, B.S.C., C.M.Z.S., an egg of Blyth's Tragopon; and on behalf of Mr. J. C. Parr, F.Z.S., a specimen of the chick of the Vulturine Guinea-fowl (*Numida vulturina*) hatched in Lancashire.—The Rev. H. H. Sclater, F.Z.S., exhibited a specimen of the Barred Warbler (*Sylvia nisoria*) obtained on the Yorkshire coast.—Mr. H. E. Dresser, F.Z.S., exhibited specimens of the Barred Warbler (*Sylvia nisoria*) and of the Icterine Warbler (*Hypolais icterina*), killed in Norfolk.—Mr W. B. Tegetmeier, F.Z.S., exhibited a specimen of the File-fish (*Balistes capriscus*), which had been recently caught off Folkestone.—Mr. F. E. Beddard, F.Z.S., read a paper on the anatomy of a gigantic Earthworm, *Microchæta rappii*, and pointed out its systematic position. For this very interesting specimen the author was indebted to the Rev. G. H. R. Fisk, C.M.Z.S., of Cape Town.—Mr. A. G. Butler, F.Z.S., gave an account of a collection of Lepidoptera made by Major J. W. Yerbury at or near Aden. The author looked upon this collection as one of the greatest interest, since it not only contained a fine series of the beautiful species of *Teracolus* recently described by Col. Swinhoe, but also many remarkable intergrades between certain long-established species, tending to prove either that hybrids between allied species are fertile, or that in Aden a condition of things still exists which in Asia proper and in Africa has long passed away.—A communication was read from Lieut.-Col. C. Swinhoe, F.Z.S., containing an account of the Lepidoptera collected by him at Kurrachee between the years 1878 and 1880.—A communication was read from Mr. Thomas H. Potts, of Ohinitaki, New Zealand, in which he described a case of hybridism between two species of Fly-catchers of the genus *Rhipidura*.

Mathematical Society, November 13.—Prof. Henrici, F.R.S., President, in the chair.—Prof. Karl Pearson was elected a member of the Society.—The Chairman in very feeling terms referred to the losses the Society and he himself personally had sustained by the deaths of Prof. Rowe, a member of the Council, and of Prof. Townsend, F.R.S., during the recess. After a slight pause, he presented the De Morgan Medal to Prof. Cayley.—The Treasurer's report, showing that the financial position of the Society was most satisfactory, and the Secretary's report having been read, the meeting balloted for and duly elected the following gentlemen to constitute the Council for the present session:—President: J. W. L. Glaisher, F.R.S.; Vice-Presidents: Dr. Henrici, F.R.S., Prof. Sylvester, F.R.S., J. J. Walker, F.R.S.; Treasurer: A. B. Kempe, F.R.S.; Secretaries: M. Jenkins, R. Tucker; other members: Prof. Cayley, F.R.S., Sir J. Cockle, F.R.S., E. B. Elliott, Prof. Greenhill, J. Hammond, H. Hart, Dr. Hirst, F.R.S., S. Roberts, F.R.S., and R. F. Scott.—Mr. Tucker then read abstracts of the following papers:—On the theory of screws in elliptic space (supplementary note), and on the theory of matrices, by A. Buchheim; on sphero-cyclides, by H. M. Jeffery, F.R.S.; results from a theory of transformation of elliptic functions, by J. Griffiths; on the limits of multiple integrals, by H. MacColl; on the motion of a viscous fluid contained in a spherical vessel, by Prof. H. Lamb, F.R.S.; on certain conics connected with a plane unicursal quartic, by R. A. Roberts; note on elliptic functions, on an integral transformation and a theorem in plane conics, by Asutosh Mukhopâdhyây. He then stated that he had found that the six Simson-lines corresponding to the angular points of the pedal and medial triangles of a given triangle with reference to the medial and pedal triangles respectively, the circum-circle being in this case the nine-point circle, co-intersect in a point which lies on the axis connecting the circum-centre and the Symmedian-point, midway between the circum-centre and the ortho-centre of the pedal triangle, and is also the centre of Mr. H. M. Taylor's circle.—The President (Prof. Henrici taking the chair) brought the meeting to a close by reading a paper on certain systems of q-series in elliptic functions, in which the exponents in the numerators and denominators are connected by recurring relations.

Geological Society, November 5.—Prof. T. G. Bonney, F.R.S., President, in the chair.—The Secretary announced the gift to the Society of a water-colour picture of the hot springs of Gardiner's River, Wyoming Territory, U.S.—The following communications were read:—On a new deposit of Pliocene age at St. Erth, fifteen miles east of the Land's End, Cornwall, by S. V. Wood, F.G.S. The deposit in question, about five miles north-east of Penzance, consisted of a tenacious blue clay with shells, resting on sand, and passing upwards into a yellow unfossiliferous clay, overlain unconformably by the earth with angular fragments, under which were buried the ancient beaches of the British Channel. Of over forty species of Mollusca obtained by the author some appeared to be wholly new, others characteristic species of the Red Crag, some not known alive, some still living. Most interesting of all, six species of Nassa were, all but one (*N. granulata*, Sow., or *granifera*, Dujardin), unknown from any formation of Northern Europe, and occurring, living or fossil, only in the southern half of Europe. Of these *Nassa mutabilis*, Linné, lived in the Mediterranean, but otherwise not north of Cadiz, while two others were new species of this southern *mutabilis* group. In the opinion of the author the bed was Pliocene, and newer rather than older, coeval with the Red Crag, but having more affinities with the Pliocene of Italy than with that of the North Sea region, a fact which seemed to indicate that during its deposition the only communication between the Atlantic and the North Sea was round the coast of Britain, a passage unavailable to the Italian group of Nassa on account of the refrigeration of its 9° of latitude. The bed was the deposit of a strait connecting the present St. Ives Bay with Mount's Bay, and detaching the high ground of the Land's End district from the rest of Britain. The shell-bearing part of the clay was 98 feet above mean-tide mark in Hayle Estuary. Dr. Gwyn Jeffreys, in a discussion on the paper, recognised among the fossils of the St. Erth deposit forty-four or forty-five species, eleven or twelve recent, thirty-three or thirty-four extinct. A bed near Antibes, in the south of France, seemed to resemble the St. Erth deposit, and the Mollusca of the two should be critically compared.—On the Cretaceous beds at Black Ven, near Lyme Regis, with some supplementary remarks on the Blackdown beds, by the Rev. W. Downes, F.G.S. The cliff section measured 300 feet in height, the Lias occupying 200 feet and the Cretaceous beds 100 feet, of which the lower 25 feet were a black loamy clay, and the upper 75 feet yellowish-brown noncalcareous sands. From one point in the clay the author obtained a few fossils, the most abundant being *Lima parallela*, and 50 feet above that point was a small patch of fragmentary silicified fossils. In the author's opinion the fauna of the sands approached the Blackdown fauna, and from all the evidence he had found, concluded that the conditions of deposition rendered it impossible to recognise in the Cretaceous beds of the West of England the subdivisions of Gault and Upper Greensand so well marked to the eastward.—On some recent discoveries in the submerged Forest of Torbay, by D. Pigeon, F.G.S. The submerged forest rested on clay, the soil in which the forest grew, which, again, rested on Trias, a breccia of Devonian fragments intervening in places. During the gales of 1883-84, two aggregations of rolled trap pebbles were found, these pebbles having probably served as smelting-hearths. In their neighbour-

hood were discovered an ingot of copper, some tin slag, a piece of glass, flint implements, &c., together with remains of piles driven into the ground—traces of human work belonging, apparently, to the Bronze Age. The author thought it the more probable view that the clay bed was deposited in a shallow marsh of land-water kept back by the sea-beach, then some hundreds of feet further to seaward, and that the forest, which consisted chiefly of willows, grew on the marsh.

EDINBURGH

Mathematical Society, November 14.—Dr. Thomas Muir, F.R.S.E., President, in the chair.—Mr. John S. Mackay read a paper on the geometrical figure known to the Greeks as "The Shoemaker's Knife."—The following office-bearers were elected:—President: Mr. A. J. G. Barclay; Vice-President: Mr. George Thom; Secretary: Mr. A. Y. Fraser; Committee: Drs. R. M. Ferguson and Thomas Muir, Messrs. R. E. Allardice, W. J. Macdonald, John S. Mackay, and David Munn.

PARIS

Academy of Sciences, November 10.—M. Rolland, President, in the chair.—Additions to the memoir on complex unities, by M. L. Kronecker.—Remarks on the fourth part of the map of Africa, presented to the Academy, on behalf of the Minister for War, by Col. Perrier. This map has been prepared by Capt. de Lannoy, of the War Department, on a scale of 1 : 2,000,000. The present part comprises the whole of the Congo region, in six sheets, which have been issued for the use of the members of the International Congress now assembled in Berlin to discuss matters relative to West Africa.—Note on Messrs. Renard and Krebs' new balloon, by M. Hervé Mangon. Two ascents were again made on Saturday, November 8, which are described as completely successful. On the first occasion the machine was propelled at an absolute speed of 23 kilometres per hour against the wind blowing at the rate of 8 kilometres per hour. The problem of directing balloons independently of aërial currents is regarded by the author as practically solved by these experiments.—Observations, elements, and ephemerides of Wolf's comet, by M. Gonnessiat. The observations were made with the Brunner 6-inch equatorial of the Lyons Observatory.—Observation of the same comet made with the meridian circle of the Bordeaux Observatory, by M. Courty.—Note on the sinuosities and variations of curvature in the shadows cast during lunar eclipses, by M. P. Lamey.—On an equation analogous to Kummer's equation, by M. E. Goursat.—On algebraic curves of any degree described on a plane, by M. Maurice d'Ocagne.—On atomic and molecular movements, by M. M. Langlois.—On the depth to which sunlight penetrates the waters of the Lake of Geneva, by MM. H. Fol and Ed. Tarasin. From a series of experiments carried out in August and September of this year the authors conclude that light reaches a depth of 170 metres and probably a little more, the luminosity at this point being about equal to that of a clear moonless night.—On a general statement of the laws of chemical equilibrium, by M. H. Le Chatelier.—Note on the polymorphism of the phosphate of silica, by MM. P. Hautefeuille and J. Margottet. The authors infer from several experiments that at temperatures ranging from 300° to 1000° C. this phosphate crystallises spontaneously in four crystallographic forms incompatible with each other, and consequently constituting four distinct chemical species.—On fluoretted apatites, by M. A. Ditte.—On the action of the primary alcoholic iodides on the fulminate of silver, by M. G. Calmels.—Anaytical study of the atmosphere of the city of Algiers, by M. Chairy.—On the hydrate of neutral sulphate of alumina, by M. P. Marguerite-Delacharlonny.—Saponification of the simple aromatic ethers of neutral substances, by M. A. Colson.—The microbe of yellow fever: prophylactic inoculation, by MM. D. Freire and Rebourgeon. After a series of extensive experiments conducted at Rio de Janeiro during the years 1880-84, Dr. Domingos Freire has succeeded in attenuating the virus of yellow fever and reducing it to a vaccinal virus. With this, 400 persons have already been treated with complete success. But fresh experiments will be needed to determine the duration of immunity obtained by this perventive inoculation.—On the effects of inflation of the lungs with compressed air, by MM. Gréhant and Quinquaud.—Researches on the genesis of saccharine in beetroot, by M. Aimé Girard.—On peptonic fermentation, by M. V. Marcano. This new process is described as a simple and economic means of preparing in a few hours extremely pure peptone at a cheap rate. It is capable of being advantageously applied in a large way to the exportation of meat in a far more nutritive and economic form than that of the extracts of meat now in use.—Origin and mode of formation of the phosphates of lime found deposited in large quantities in sedimentary lands: their connection with the iron ores and clays of siderolithic levels, by M. Dieulefait.—Contributions to the anatomy and morphology of the Malpighian vessels in the Lepidoptera, by M. N. Cholodkovsky. Completion of the biological evolution of *Chaitophorus aceris*, Fabricius (sub-Aphis), by M. J. Lichtenstein.—Note on the characteristics of a Tertiary Conifer (*Araucarites Sternbergi*, Goepp.) allied to the Dammareæ (*Doliostrobus Sternbergi*), by M. A. F. Marion.—On a great oscillation of the Cretaceous seas in Provence, by M. L. Collot.—On the limestones containing fossil Echinids occurring at Stramberg, Moravia, by M. G. Cotteau.—Observations of the solar corona in Algeria, by M. E. Fuchs.—Account of a magnificent meteor observed at Morges on November 3, by M. Ch. Dufour.

VIENNA

Imperial Academy of Sciences, October 16.—On bodies with a maximum of density, and on the conclusions derived from their behaviour, by C. Puschl.—On the passing of luminous rays through glass pipes, and on a method based thereupon for determining the refractive indices of condensed gases, by T. Dechant.—On the influence of pressure on the magnetisation of iron and steel rods, by H. T. Ibrailean.—Computation of the orbit of the planet Cœlestina (237), discovered by T. Palisa on June 27, by F. von Oppolzer.—Geographical determination of the place of San'a (capital of the Yemen Vilayet), by E. Glaser.—Calculation of the orbit of Wolf's comet, by K. Zelbr.—On the action of zinc-ethyl on $\alpha\beta$ dichlorocrotonaldehyde, by A. Lieben.

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THURSDAY, NOVEMBER 27, 1884

OVER-PRESSURE IN ELEMENTARY SCHOOLS

THERE has lately arisen a warm controversy about over-pressure in schools, and its alleged results. The points in dispute are unquestionably important, and deserve the careful thought of all those who are interested in the intellectual and physical development of the rising generation. The cry of over-pressure was raised some years ago with reference to middle-class schools, and during the discussion of the Proposals of the Education Department for the New Code it extended to elementary schools. The National Union of Elementary Teachers took up the subject at their meeting at Sheffield during the Easter week of 1882. In July they had an important conference with Members of Parliament at the House of Commons, and they have continued ever since to agitate for a relaxation of Government requirements. Their views were supported by the opinions of several medical men, and were gladly seized hold of by the opponents of the education of the people. The matter came before the Social Science Congress at Huddersfield and the Health Exhibition at South Kensington. It has been investigated and reported on by several School Boards. The *Times* has dealt with it in able leading articles, and the *Pall Mall* in prettily written "Idylls." The Education Department itself, and both Houses of Parliament, have been stirred by it, while the personal combat between Dr. Crichton Browne, one of the Lord Chancellor's Visitors, on the one side, and Mr. Fitch, one of the best known and most highly esteemed of Her Majesty's Inspectors, on the other, has added a flavour to the controversy.

The question is a large and complicated one. In dealing with it I have no intention of touching on any personal matters in dispute, nor of speaking of the pressure on School Board members, or on teachers. Our educational systems exist for the sake of the children, and must stand or fall according to the effect upon them. My remarks also will be restricted to public elementary schools, whether "voluntary" or "Board," though I do not believe that they are so open to the charge of over-pressure as many of our middle-class or higher schools.

The allegations are of the most serious order. It is not so much that here and there one poor child dies of disease brought on by over-work; but it is held that the bodies of our scholars are being systematically sacrificed to an abnormal development of their minds, and that there is growing up a generation whose nerves are over-strung, and who are becoming more and more liable to diseases of the brain and connected organs. The defenders of the present system, however, assert that these charges are enormously exaggerated, and that all reasonable precautions are taken against the occurrence of the evil.

In all this conflict it is difficult to find evidence of a scientific character; there is more rhetoric than argument, and even when the figures of speech are supplemented by statistics, the conclusions drawn from them seem open to question. There are, however, two conclusions which will scarcely be disputed by any one who has looked at the matter with any amount of impartiality.

(1) *That in all large schools there are children who are in danger of over-pressure.* Take the typical case of a class of seventy children, starting with about the same attainments. The bulk of these will be average boys, or girls, as the case may be, fairly healthy and intelligent, not given to over-much study, but still ready to fall in with the requirements of the school. But there will also be some half-starved children, who often come without any breakfast, dull children—descendants of a wholly uncultured race—feeble children, and others averse to any restraint and constitutionally irritable, together with children who are weary with toil at home, or with hanging about late at night, or working early in the morning before they go to school. Besides these there are the exceptionally clever children, who are in danger of under-pressure, and the over-sensitive or ambitious, who are prone to over-work themselves if allowed the opportunity. It is evident that the general scope of the instruction must be adapted to the average of the class. To reduce it to the level of the physically or mentally weak would be a cruel wrong to the majority of the children, and an injustice to the public, who, by means of taxes, rates, or voluntary contributions, mainly support the school.[1] But this insures the possibility of more being expected from some of the other boys or girls than they have the power to perform. This danger is aggravated where, as in many country parishes, it is difficult to raise sufficient funds to provide a proper staff and appliances for teaching, while the very existence of the school is dependent upon each child earning as large a Government grant as possible. The danger is aggravated also by the shocking irregularity with which those children attend who are driven in from the streets. Happily elementary schools are usually exempt from one prolific source of over-pressure—competitive examinations. The annual Government examination is simply for a pass, and is looked forward to with pleasure by the majority of the children.[2] The practice of the more important bodies of management is, I believe, similar in this respect to that of the London School Board, which recognises no competition between one child and another, unless it be for the Scripture prizes and a few scholarships, which it administers for other parties.

(2) *That in a large number of instances the circumstances of school life are more favourable to health than the home life.* Before the days of compulsory education many thousands of children passed a joyless existence shut up in close and often fetid rooms, or turned out in all weathers into the streets or alleys. Now these children are brought into warm, well-lighted, and well-ventilated school-rooms, where habits of cleanliness and self-respect are inculcated, and where both their bodies and minds are duly exercised. This is especially the case in the newly-constructed Board schools. It is difficult to show this improvement by statistics of health, but we have the statistics of death. The Registrar-General, having been applied to on this matter, reported that "the death-rate of children (from five to fifteen years of age) in 1861-70 was 6·3 per 1000. It fell in 1871-80 to 5·1 per

[1] So far from the majority of the children being over-pressed, it is admitted by Dr. Crichton Browne that 70 or 80 per cent. can accomplish the annual work required by the Code easily.

[2] An attendance-officer, formerly a schoolmaster, has just written to me as follows:—"I have ever found the children looking anxiously and joyously forward to the day of examination, so much so that it would be nothing short of absolute cruelty to deprive any of those dear little souls of their long-hoped-for privilege."

1000, a decline of 19·05 per cent."; that "the main part in this fall was due to diminished mortality from the chief zymotic diseases"; that death from other diseases had also declined, "whereas the death-rate from nervous affections remained unaffected," or, possibly, slightly increased. A diminution of 19 per cent. in the death-rate is a great gain, and that this is not to be wholly or mainly attributed to improved sanitary conditions in their dwellings is shown by the fact that the diminution of mortality is much smaller in children under the school age.[1] But the question arises, granted that going to school is in the main favourable to health, what about these nervous diseases? Is their probable increase the result of increased attendance at school during the last decade? Dr. Crichton Browne has drawn out and discussed at great length the statistics of lunacy and the mortality from hydrocephalus, cephalitis, diabetes, nephritis, Bright's disease, uræmia, rheumatic fever, and rheumatism, and shows that during the five years 1876–80 there was an increase of these diseases. But the remarkable fact comes out that this increase has affected all ages. The increase of death from diseases of the kidneys has been greater among persons of twenty years and upwards, and the increase from inflammation of the brain and its membranes has been greater among children under five years of age than among those who have attended school during the period in question.

But the statistics of disease would be more valuable than those of death. Unfortunately they scarcely exist. Dr. Crichton Browne has, however, tabulated the results of his inquiries on this subject in eleven London schools. In regard to headache, to which he has naturally paid great attention, he has arrived at the startling conclusion that "as many as 46·1 per cent. of the children attending elementary schools suffer from habitual headache." He analyses the nature of these headaches very fully, but to ask a class of children to hold up their hands in response to the question, "How many boys or girls here suffer from headaches often, or now and then?" is far from being a scientific method of procedure. His tables of comparison between the different Standards seem to me more valuable as evidence. If any real mischief is going on in our schools, it will betray itself in the evil being more apparent among those children who have been longest at school. In the case of short-sightedness, which, from investigations on the Continent, Mr. Brudenell Carter's inquiries at home, and other sources of information, we know to be a growing malady, the increasing percentage from Standard I. to Standard VI. is very apparent from Dr. Browne's table, rising, as it does, from 2·5 to 9·2. In the case of headache there is a slight increase; but in the case of sleeplessness and neuralgia or toothache there is a very marked decrease. No doubt the inquiry is a very complex one, and it is impossible to separate the different factors in the result, but these tables certainly invalidate rather than support the opinion that the nervous systems of the children in our primary schools are being seriously undermined.

In so important a matter as the health of the rising generation we should welcome any additional knowledge that may be the outcome of this controversy; but the point of practical importance is how to maintain to the utmost the beneficial results of our educational system, and at the same time avoid the danger of over-pressure in individual instances or under specially unfavourable circumstances.

The provisions of the Mundella Code and the recent Instructions to Her Majesty's Inspectors ought to be fully carried out. In Article 8 of the Code managers are stated to be held responsible "for the care of the health of individual scholars, who may need to be withheld from examination or relieved from some part of the school work throughout the year." In Article 109 it is stated: "The inspector will also satisfy himself that the teacher has neither withheld scholars improperly from examination, nor unduly pressed those who are dull or delicate in preparation for it at any time of the year; and that, in classifying them for instruction, regard has been paid to their health, their age, and their mental capacity, as well as to their due progress in learning." The local managers are also considered the best judges of the special circumstances which render it inexpedient to require home lessons. But how are managers to judge of the health of individual children? The proposal that a monthly record of the height, weight, head and chest girth of all the children should be kept in every school is not likely to be adopted, on account of the enormous additional expense which it would entail; but it would not seem impracticable to draw up some simple regulations for teachers or managers which might enable them to detect an anæmic or neurotic condition or the incipient stages of nervous malady.

A guard ought to be set against those practices which tend to over-pressure. These are pretty well known to practical teachers. The London Board has during the last two or three years taken several steps in this direction. The teachers used to be paid partly from the Government grant, and thus had a pecuniary incentive to press forward the feeble, so as to insure their passing the examination. There were great difficulties in altering these arrangements, but it was accomplished at the close of last year. It is a common practice to prolong the hours of teaching, especially shortly before the inspector's visit; this was objected to by the London Board four years ago, and now is forbidden. Home lessons are left optional with the teachers and the parents. Improved physical exercises for girls have been introduced. The Education Department has been induced to diminish the excessive requirements of the Code in regard to needlework. Arrangements also are being made for relieving the pupil-teachers to a large extent from their labours in the schools.

It is to be hoped that one beneficial result of this discussion will be an increased perception of the necessity of variety in the subjects of instruction. In the words of Mr. E. N. Buxton, Chairman of the London Board, "It is monotony which kills; indeed, we look to a wholesome variety as a means of welcome relief." Happily the Code now requires "varied and appropriate occupations in infant schools;" and this is largely insisted on in the recent Instructions to Her Majesty's Inspectors. The dreary monotony of the three R's in the 1st Standard and in backward schools should be relieved by object-lessons or other interesting occupations, and literary studies should be balanced by the elements of science as well as by drawing,

[1] This matter is discussed in the *Statistical Journal* for June 1883 and June 1884.

singing, drill, and cookery or handicraft. It is a matter of common experience that whatever increases the vigour or quickens the intelligence of children enables them to acquire book-learning in a much shorter space of time. In whatever points educationists may differ, there will be a general agreement that the bodily senses of our young working-class population ought to be developed as well as their mental faculties, and that it is highly important for them at least to know something of the world in which they live and of the materials and natural forces with which they work.

J. H. GLADSTONE

THE DISTRIBUTION OF THE METEOROLOGICAL ELEMENTS IN CYCLONES AND ANTICYCLONES

Sur la Distribution des Éléments Météorologiques autour des Minima et des Maxima Barométriques. Par H. Hildebrand Hildebrandsson. Présenté à la Société Royale des Sciences d'Upsal le 10 Mars, 1883. (Upsal, 1883.)

WITH the publication of the first synoptic weather-maps in Europe and America about the middle of the present century, the scientific study of the great movements of the atmosphere and other phenomena of weather may be considered as having commenced. This method of inquiry soon taught us that in different parts of one and the same barometric depression or cyclone, very different climatic conditions prevailed. In the front part of the depression the weather is warm, moist, and clouded, whilst in the rear it is cold, dry, and clear. Further inquiry showed equally distinct types of weather characterising different parts of high-pressure areas or anticyclones. So close indeed are these relations that the study of weather resolves itself very much into an examination of the phenomena attending cyclones and anticyclones. If we could certainly prognose the distribution of atmospheric pressure over North-Western Europe on, say, Saturday next, we could for the same time forecast pretty correctly the weather over this part of the earth. Similarly, if we could forecast that the easterly tracks of the cyclones of the coming winter were to be south of the Channel, we could forecast a severe winter for the British Islands; and on the other hand if the path taken by these cyclones would be to the north of these islands, an unusually mild winter would certainly follow. Hence the supreme importance of any accession to our knowledge respecting cyclones and anticyclones. This is what Prof. Hildebrandsson's laborious and able paper does in various directions.

The direction and velocity of the wind as noted at Upsala at the surface of the earth, in the region of the lower clouds, and in the higher region of the cirrus, the temperature of the air, the amount of cloud, the frequency of rain, the transparency of the air, and the occurrence of fog are examined with reference to forty-three different sections or areas into which the author has partitioned cyclonic and anticyclonic systems according to the direction of the barometric gradient and the height of the barometer, three of these forty-three sections being the central areas of the cyclone and the anticyclone, and the space separating two cyclones which are not far apart.

As regards the direction of the wind it is shown that the angle made by the wind with the barometric gradient is greater in summer than in winter; greater at stations near the sea than at inland places; greater in cyclonic than in anticyclonic regions; and that the angle is the maximum, or the wind approximates most nearly to a circular course, when the gradient is directed towards the east, and the minimum when directed towards the west. The angle obtained for Upsala, which is nearly 50°, is greater than that obtained by Loomis for the United States, but less than what Mohn has found for Norway and Clement Ley for the British Islands. The observations made on three small islands were also examined, viz. Utklippan, a little to the south of Karlskrona, Wäderöbod, north-east of Jutland and a few miles off the Swedish coast, and Sandön, a low sand-bank about thirty-four miles north of Gothland, at which stations the angles are respectively 64°, 65°, and 74°. Here the influence of the sea on the angle made by the wind with the gradient is very striking, being about a half more at the strictly insular position of Sandön than at Upsala.

The angle is at the maximum in the three islands when the gradient is directed towards the east, and the minimum when directed towards the west, as at Upsala, and as Clement Ley has shown for England, Hoffmeyer for Denmark, and Spindler for Russia. One remarkable result is, however, shown with reference to each of the three islands, viz. the angle shows a well-pronounced secondary maximum when the gradient is directed towards the north-west. It is premature to attempt an explanation of the different degrees of the incurving of the wind upon the centre in the different parts of a cyclone, until similar results have been worked out for a large number of well-selected individual stations, and until a more definite knowledge is arrived at regarding the relative prevalence of ascending and descending aërial currents in the different sections of the cyclone and anticyclone.

The velocity of the wind is the minimum near the centres of cyclones and anticyclones, and in the middle space between the cyclones. From the central region of the anticyclone, the velocity of the wind increases as the barometer falls, and the maximum velocity is reached on approaching the calm central region of the cyclone. With respect to the gradients, the greatest velocity appears to occur when the gradient is directed towards the north and the least when the gradient is towards the west or the south-west.

In the region of the lower clouds, the wind takes a direction to the right of that of the wind at the surface of the earth. In other words, at this height the winds tend to follow the course of the isobars drawn for the sea-leve pressure, with however two noteworthy exceptions. When the gradient is directed towards the west, the angle exceeds 90°; but when directed towards the south or south-east, it is markedly less than 90°.

In the higher region of the cirrus clouds, the winds blow centrifugally from the region of the cyclone towards that of the anticyclone. The velocity is least in the vicinity of the central region of the cyclone, but it steadily increases as it approaches and flows over the region of the anticyclone. The centrifugal movement is greater in

the front than in the rear of a cyclone, where indeed the motion of the cirrus cloud approaches the direction of the lower clouds and of the wind at the surface of the earth. The direction of the cirrus immediately behind and over the centre of depression is in Sweden generally from north or west, but, from the exceptions which occur, it is evident that more observations and discussions of the results are required.

Fog is of most frequent occurrence when the gradient is directed towards the north and least frequent when directed towards the south. In the Kattegat, fog attains its maximum frequency in the region situated between the lowest and the highest pressures. At Upsala the clearness of the air is nearly independent of barometric pressure, there being, however, a greater tendency to mistiness in the air when the gradient is directed towards the west than other directions. Cloud and rain are most frequent with gradients to the south or west, and least with gradients to the north-east. In summer, they regularly diminish as pressure increases; but in winter, less regularly, inasmuch as the strato-cumulus, which are the most common clouds in this season, are most numerous in times of high pressure and occasionally bring with them slight showers of snow.

In winter, temperature is above the mean both in cyclones and anticyclones when the gradient is directed towards the west, and below it when directed towards the east. In the same season, temperature rises on all sides towards the centre of the cyclone; in other words, the thermometer rises as the barometer falls, and *vice versâ*. In winter also temperature is ordinarily above the mean in cyclones, but under it in anticyclones and in the region between two cyclones; in summer the reverse holds good—these results being due to the different effects of solar and terrestrial radiation in these seasons.

With reference to the distribution of temperature with height, Hildebrandsson has examined the observations made at the Puy-de-Dôme and at Clermont Ferrand, near the base of the mountain in connection with the cyclones and anticyclones in that part of Europe during 1877-82. The difference between the temperatures of the two places in winter attains the maximum in the vicinity of the centre of a cyclone, and the difference diminishes according as the barometer rises, and the minimum is reached near the centre of the anticyclone, where temperature on the mean is higher at the higher station, the difference in height being 3516 feet. In such investigations, this high-level station, as well as the high-level stations in the south of France, in Switzerland, and Austria, have the disadvantage of being almost always on the north-west slope of anticyclonic areas, the centres of which are situated in a south-westerly direction. It is on rare occasions that well-marked cyclones cross these stations, and still rarer that cyclones pass to the south-west of them. Prof. Hildebrandsson states his opinion that, for the prosecution of these all-important researches, Ben Nevis, with its low- and high-level stations, occupies what is, perhaps, the most favourable position in the world, seeing that it is situated in the track of the greater part of the Atlantic storms which sweep over North-Western Europe, and that the publication of the observations *in extenso* would be an important gain to science.

"*FLATLAND*"

Flatland: a Romance of Many Dimensions. With Illustrations by the Author, A Square. (London: Seeley and Co., 1884.)

WE live in an age of adventure. Men are ready to join in expeditions to the North Pole or to the interior of the African continent, yet we will venture to say that the work before us describes a vast plain as yet untrodden by any Fellow of the Royal Geographical Society, and teeming with a population of which no example has figured in any of our shows. A few years ago a distinguished mathematician published some speculations on the existence of a book-worm "cabin'd, cribb'd, confin'd" within the narrow limits of an ordinary sheet of paper, and another writer bewailed "the dreary infinities of homoloidal space." A third remarks, "there is no logical impossibility in conceiving the existence of intelligent beings, living on and moving along the surface of any solid body, who are able to perceive nothing but what exists on this surface and insensible to all beyond it." How delighted Prof. Helmholtz will be to find, if this Flatland writer is worthy of credence, his conjecture thus verified. "Flatland" is not the real name of this unknown land (that secret is not divulged), but it is so called here to make its character clear to us Space-denizens. It is a noteworthy fact that one at least of the Flatlanders expresses himself in remarkably correct English, and singularly after the manner of an ordinary Space-human being; and further, though—we regret to have to record it—as a martyr in the cause of the truth of a third dimension, he has spent seven long years in the State jail, yet these memoirs have in some mysterious manner found their way into our hands. There is hope then that some one of our readers may yet expatiate in the broad plain, though the penalty will be, we fear, that he must first become as flat as a pancake and then see to it that his configuration (as a triangle, square, or other figure) is regular. This latter is a *sine quâ non* in Flatland, because, whatever you are, your configuration must be regular, or woe betide you, and you will shuffle off your mortal coil incontinently.

We will not stop to inquire how this and that have come about, but will endeavour to lay before our readers some of the features of this (to us) new world, though we are informed that it has just entered upon its third millennium.[1]

In Flatland there is no sun nor any light to make shadows, but there is fog. This, which we on this earth consider to be an unmitigated nuisance, is recognised in that other world "as a blessing scarcely inferior to air itself, and as the Nurse of Arts and Parent of Sciences." If there were no fog, all lines would be equally distinct, whereas under present circumstances, "by careful and constant experimental observation of comparative dimness and clearness, we are enabled to infer with great exactness the configuration of the object observed." It is a necessity of Flatland life to know the north (for instance, it is a point of good breeding to give a lady the north side of the way); this is determined in the absence

[1] From the secret Archives it appears that at the commencement of each millennium a Sphere descended into the midst of the Council of Circles proclaiming the great truth for the attempted teaching of which our author is in bonds.

of any heavenly bodies by a novel (we speak as a Space-denizen) law of Nature, viz. the constancy of an attraction to the south: however, in temperate regions the southward attraction is scarcely felt, but here again Nature comes to the Flatlander's aid. If he is in an inhabited region, the fact that the houses (mostly regular pentagons; squares and triangles are only allowed in the case of powder-magazines, barracks, and such like, for sufficient reasons) have their roofs towards the north, so that the rain, which always comes from that quarter, may run off and not damage the houses, will help him to get his north point. If, however, he is out in the country far away from trees and houses, there is no help for him until a shower of rain comes. We must now give some description of the inhabitants. The women are all straight lines; the men are other regular figures (if there be hopeless irregularity, which the hospitals cannot cure, then the man is put to death). The lowest orders, policemen, soldiers, and the *canaille*, are isosceles triangles, their mental calibre being determined by the largeness or smallness of the vertical angle. It is possible for an isosceles triangle to be developed into an equilateral triangle, or the offspring after a few generations may be so developed: in this class are the respectable tradesmen. The professional men and gentlemen are Squares—our author is a lawyer—and Pentagons. The Circles (that is, approximations more or less closely to that figure) are the nobility.

Another law of Nature in Flatland is that "a male child shall have one more side than his father, so that each generation shall rise (as a rule) one step in the scale of development and nobility." Our author, as appears by the drawing on the cover, has four pentagonal sons and two hexagonal grandsons. We do not clearly gather where the one eye (for Flatlanders appear to be monoculi) is situated, and how locomotion is effected we are not told. It can hardly be by such means as were once suggested by Prof. Clerk Maxwell, for in Flatland you must go steadily forward or dire may be the disaster you will inflict upon your neighbour. There seems to be no lack of Board schools, and there is at least one university, that of Wentbridge (we had by force of habit written Cambridge), where instruction is given in mathematics. A knowledge of this branch of study is obligatory, for since a Flatlander's eye can only move in his world-plane, all the objects, human and otherwise, even the circular priests, appear to be straight lines, and the figure-angles have to be, at any rate approximately, correctly guessed at sight.

Before we close our notice we must return to the description of the womankind. The women we have said are straight lines, hence they are very formidable, for they are like needles, and what makes them more to be dreaded is that they have the power of making themselves practically invisible, hence a Flatland female is "a creature by no means to be trifled with." There are, however, certain regulations in force which diminish the dangers resulting from having a woman about the house. There is an entrance for her on the eastern side of the house, by which she must enter "in a becoming and respectful manner"; she must also, when walking, keep up her peace-cry, under penalty of death, and if she has fits, is given to sneezing, or in any way is liable to any sudden movement, there is but one cure for such movements, and that is instant destruction. Though involuntary and sudden motions are thus summarily dealt with, yet if she is in any public place she must keep up a gentle "back-motion," and thus she is less liable to be invisible to her neighbours. Happily fashion exercises its potent sway in Flatland female society, as elsewhere, for we learn that "the rhythmical, and, if I may so say, well-modulated undulation of the back in our ladies of circular rank is envied and imitated by the wife of a common Equilateral, who can achieve nothing beyond a mere monotonous swing, like the ticking of a pendulum." Owing to their unfortunate configuration they are inferior in all good qualities to the very lowest of the Isosceles, being entirely devoid of brain-power, and they have "neither reflection, judgment, nor forethought, and hardly any memory." This is but a poor account, but we must bear in mind that it is an *ex parte* description by a Square who may at some time have suffered a disappointment at the hands of a lady. We shall be glad (though we can hardly expect such a result)—now that tidings have come from this little-known country—if some female will favour us with her view of the state of matters in Flatland. At birth a female is about an inch long, a tall adult woman reaches to about a foot. The length of the sides of an adult male of every class may be said to be three feet or a little more.

The book consists of two parts—*This World*, *i.e.* of Flatland, in twelve sections, and *Other Worlds*, in ten sections. The whole is very cleverly worked out, and many passages descriptive of events in the past history of the country at times force upon one the thought that after all the book may have been compiled by a Space-denizen, and that he is quietly laughing in his sleeve and saying, "de te Fabula narratur." However this may be, Flatlander or Spacelander, there is a slip in the note on p. 64, and for "Flatland" should be read "Spaceland."

We commend "A Square's" book to any of our readers who have a leisure hour from severer studies, and we believe when they have read it they will say "the tenth part of the humour has not been suggested" by our description.[1]

R. TUCKER

OUR BOOK SHELF

The First Principles of Natural Philosophy. By W. T. Lynn, B.A., F.R.A.S. Second Edition. (London: Van Voorst, 1884.)

IT is a little difficult to see what useful purpose is served by this work, or why a second edition should be called for, seeing that it is neither of the popular nor yet of the properly scientific order of text-book. Its modes of regarding and describing the facts of dynamics are antiquated and incorrect, and it is extremely barren in numerical illustrations of the kind most helpful to elementary students. The author begins by telling the reader that "a pulling force takes the name of a tension," whilst "a pushing force" takes "that of a thrust." He then gives in abbreviated form Duchayla's proof of the parallelogram of forces, "because it is the foundation of the whole theory of statics," in spite of its essential faultiness in requiring more assumptions in the course of the argument than if the simple rule of compo-

[1] We may mention as specially humorous the chapters in which the Square is initiated into some of the mysteries of tri-dimensional space by the spherical stranger.

sition of vectors were assumed outright. The author is probably now the only surviving writer on dynamics who persists in muddling up force and acceleration by calling acceleration (a purely kinematical quantity in itself) an "accelerating force," and he adds to the muddle by writing $v = ft$ where all modern writers would put $v = at$. What the student is to understand by "a force capable of generating in one second a velocity represented by DE" (p. 27) is difficult to see, when the mass on which the force is to act is nowhere stated, and when it is not even stated or hinted that there is any mass at all to be acted on. On p. 41 the author states that "in this country the ounce avoirdupois is so taken that one thousand of them will just balance a cubic foot of distilled water." This is not so, at least in *this* country, for the mass of the ounce depends on the standard pound, and this was established without any reference to a standard volume of water. The definition is wrong; the fact it states is a mere coincidence; and the coincidence itself is not exact: a cubic foot of water does *not* weigh 1000 ounces. On the same page the author tells the reader to ascertain with respect to a certain mass the velocity which "a given pressure or impulse" will impress upon it; "the mass being inversely proportional to this velocity." The confusion between *pressure*, which cannot be expressed except in terms of force divided by area, and *impulse*, which is expressed as force multiplied by time, is truly amazing. Is time the reciprocal of an area? Again, on page 42 the author is speaking of a certain force capable of sustaining a certain weight for one second of time, and he says "it would require twice as powerful a force to enable it to resist the action of gravity for two seconds, three times for three, and so on." This is news indeed. In the section on hydrostatics, no sooner has the student learned that a pressure of one pound per square inch is equal to 100 lbs. per 100 square inches, than he comes to such a statement as the following (p. 52): "The pressure therefore exerted by a mass of fluid upon the bottom of a vessel containing it is proportional to the area of the base," &c. Here the author jumps, without one word of warning to the student as to his change in the use of words, from using the word pressure in its proper sense of so many *pounds-per-square-inch*, to using the word in the sense of so many *pounds*, in which case it is no longer a 'pressure" but a "force." It may be said perhaps that these things are but slips of the pen. Perhaps they are; but in a teacher who undertakes to write a text-book of "first principles" slips of such a kind are unpardonable. No such confusion of thought would be tolerated in the pupil who had read Wormell's "Dynamics," or Lodge's "Mechanics," or Maxwell's "Matter and Motion," or Thomson and Tait's lesser volume. If Mr. Lynn does not intend his text-book to be cast aside as worse than useless, he must at once correct blundering modes of thought that can only mislead the student.

Éléments de Mécanique, avec de nombreux Exercices. Par F. I. C. Pp. 282. (Paris: Poussielgue Frères.)

THIS is the concluding volume of a series of elementary class-books on pure and applied mathematics issued by l'Institut des Frères Écoles chrétiennes, a French Society which showed in the Technical Schools at the recent Health Exhibition a noteworthy collection of specimens of work done in their schools, along with the educational apparatus used therein.

The character of the book before us harmonises with the evident sympathy of the Society with the manufacturing industries of the districts in which their schools are situated. We are furnished with an introduction to applied as well as to theoretical mechanics. There are good diagrams and descriptions of weighing-machines, cranes, and other lifting-tackle in the section on statics; the longest chapter in kinematics is concerned with the simpler forms of mechanism; and in dynamics there is a full discussion of the principle of work and its application to mechanics.

The text is clear, as far as it goes; but we think the general exposition of the theory too concise, many important points being relegated to the exercises at the end of each chapter.

There is a good collection of problems filling the last fifty pages of the book, but no examples are worked out in the text, and there are no results given to any of the exercises. Clearly, pupils using the book would require a good teacher at hand, who could devote ample time to the subject.

We should wish to see a book like this with a few select students, but, having regard to general class instruction, we do not think the mode of treatment a happy one. We feel called upon, however, to give a cordial recognition to the expansion in the direction of technical instruction, to the liberal supply of good diagrams, and to much freshness of treatment, both in text and examples, in the work before us. A. R. W.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Chemical Research in Great Britain

AT the anniversary meeting of the Chemical Society held March 31, 1884, the President read an address to the Fellows, which contains a series of remarks upon the prosecution of original research in England requiring some notice, particularly as a separate issue of the address has been circulated by the author. Attention is directed to the fact that we have an increased number of laboratories in Great Britain[1] and greater facilities for the prosecution of research through the aid of the Government grant and the Chemical Society's fund. Notwithstanding this the startling and anomalous fact is to be observed that the number of papers read before the Society is declining year by year.

After speaking in terms of praise of the degree of Doctor of Philosophy of Germany, which necessitates the prosecution of some original investigation, there follow some remarks which read like a serious reflection on a number of professors who have won distinction through unremunerative devotion to scientific teaching and research.

"The past neglect of research will, it is to be feared, have a more lasting influence on the progress of chemistry in this country than may appear at first sight, and in this way. Those who have been students in laboratories where the importance of this kind of work is not recognised, advance in their positions, becoming assistant demonstrators, &c., and eventually professors, and as they have not learnt to practically realise the value of research by being in the habit of conducting it themselves, or of seeing others do so, when they become professors they will naturally not encourage students to undertake it in their laboratories, and it is to be feared that we are already suffering in this way, and that this is one of the causes why the new laboratories which have been opened are doing so little to add to our store of fresh knowledge."

It will be questioned whether such a statement can be justified when it is mentioned that there happens to be lying on the table before the writer four reprints of papers recently received from the respective Professors of Chemistry in four of the new colleges; three of these memoirs are published in the *Philosophical Transactions* of the Royal Society, while a fifth occupant of one of the newly created chairs not long since received the Longstaff Medal. The whole subject seems scarcely to have been so well considered as to lead to a just appreciation of the cir-

[1] The term used is the United Kingdom, which includes Ireland. There has been no increase in the number of laboratories in Ireland, and only an increase of one in Scotland.

cumstances which give rise to unfavourable comparisons between scientific work in Great Britain and on the Continent.

But let us deal with the decline in the number of contributions to the Chemical Society. In 1880-81 there were 113 communications; in 1881-82, 87; in 1882-83, 70; and in 1883-84, 67. To what may this decline be assignable? In the first place the Chemical Society is not the only body in the United Kingdom which publishes papers on chemistry; there are the Royal Society of London, the Royal Society of Edinburgh, and five others, including the important Society of Chemical Industry. There are two societies in Dublin, but in this discussion Ireland will be left entirely out of the question. Causes not easily definable may lead to the transfer of authors' works to one or other of these bodies instead of to the Chemical Society. In fact these figures inform us that as the Society of Chemical Industry sprang into being and increased in importance so did the number of contributions to the Chemical Society diminish, and those to the younger body increase. We find that in 1883-84, the second year of its existence, there were sixty-eight papers read at the meetings of the Society of Chemical Industry, and the President will probably have to congratulate the members upon a still further increase at the next anniversary meeting. This is not all; the number of papers is no criterion of the excellence of the work done, and it may be maintained that the importance of the published communications has very distinctly increased, and if this be admitted it is self-evident that with increased elaboration, provided the same amount of work be expended, numerical decline must follow. In comparing the number of papers published in the *Transactions* of the Chemical Society with those in the Berlin *Berichte*, there is also an element of unjust reckoning, inasmuch as the latter volume includes the work of chemists not only distributed throughout the whole German Empire, but of many natives of eight other countries of Europe, occasionally a contingent from America, and even one or two from England. A strict examination will show that our shortcomings are scarcely so considerable as they appear from the President's representation.

Let us now consider what influence on original work may be expected from an increased number of laboratories and colleges. It is made to appear as if the fault which renders comparisons unfavourable to us lies entirely with the teachers. This is unwarrantable because, for the amount of instruction given, the proportion of professors and lecturers in Great Britain is much smaller than in Germany. Courses of lectures on theoretical chemistry—inorganic and organic—metallurgy, and applied chemistry, are not unusually required from one professor, who sometimes in addition is expected to lecture at night to artisans. In one or two cases he has to treat of physics, and is styled the Professor of Chemistry and Physics. Such labour would never fall to the lot of any German professor. For the sake of brevity all reference to the paucity and insufficiency of the endowment of the chairs may be omitted, as likewise the motives for study which influence the attendance in the new colleges.

It may well be doubted whether the President of the Chemical Society had earnestly sought to make himself acquainted with the course of instruction pursued in most English laboratories, and realised the difficulties in the prosecution of research by students which are known only to teachers. Medical students, for instance, pay their fees for a certain well-defined course of instruction, and always see that they get it. The lecturers and professors in other colleges, such as those recently established, would neglect their duty if they did not follow out the programme of studies drawn up by the respective Boards and Councils. The town councils, associations of manufacturers, and public-spirited gentlemen who establish the new colleges have been taught to believe that our manufactures and scientific industries are languishing for want of technical education, which must be supplied to masters, superintendents, foremen, and workmen. Their schemes of education are based on the requirements of such a class of students, and they are bound to comply with the demands made upon them. Hence it arises that a three years' course of study is devoted to mathematics, mechanics, drawing, physics, chemistry, and engineering. Chemistry in England is either a branch of general education, a professional, or a technical study, but seldom is it pursued for its own sake. From upwards of 1000 students taught in the laboratories of a single college during a period of nine years, only seven men can be counted who prosecuted their studies with any idea of making themselves chemists, and of these, five were the authors of researches pursued during their college career, which were published in the Chemical Society's *Journal*.

In the German Empire there are twenty-two Universities, all departments of the State, with professors, lecturers, demonstrators, assistants, buildings, and laboratory equipments provided and maintained by funds from the respective Governments. There are about two thousand teachers and twenty-five thousand students annually pursuing all branches of learning. Science, and experimental science especially, is valued to the same extent as classical and mathematical training in England; chemistry especially receives great attention, as is shown by the fact that the above figures include one hundred and twenty professors of chemistry, sixty of whom are "ordentliche Professoren." The cause of this has been attributed by some to the teachings of Liebig and those of his school. The result is that a student occupies himself with the most recondite branches of chemistry, physics, and cognate subjects, without having in view any immediate application of his knowledge or research either to the requirements of a professional career or those of a scientific industry. This is shown by the period spent at the University being longer than is necessary for such a purpose. Tradition has placed the learning of the schools of Oxford and Cambridge on a higher platform than that of science, and we cannot alter in thirty years that which has existed in men's minds for more than three centuries,[1] unless indeed we can call to our aid an intellect like that of Liebig placed in a position of great influence. It would, however, be a national misfortune if other branches of learning were to suffer for the benefit of science.

The recently-established colleges in the manufacturing districts differ from the Universities, and are more nearly allied to the special schools or Polytechnics of the Continent; but, in addition to providing the education of such establishments, they have to perform the functions of University colleges, of medical schools, and frequently also of superior mechanics' institutes, generally with a staff inadequate for the purpose. For the most part knowledge is acquired in such institutions only to serve as an aid to improving manufactures. There are on the Continent, not counting France, eleven Polytechnics, or high schools, built at a cost of not less than three millions sterling, and maintained by an annual expenditure of 200,000*l*. In "Les Allemands," by Le Père Didon, it is remarked that the prosperity of highly-cultivated nations depends upon the prosperity of the special schools and the Universities together, but there is a danger when the prosperity of the former leads to a decline in the popularity of the latter. In the work quoted, England is cited as an example of the inconveniences that arise from a want of equilibrium between professional education and the more theoretical and speculative teaching of the Universities. The dominating studies of classical literature, pure mathematics, philosophy, history, and theology of Oxford and Cambridge cause students of the middle class too frequently to pass at once to the professional colleges of medicine, engineering, &c., instead of educating professional men up to that level of general knowledge without which the most able specialist is wanting in a great essential to success in life.

That originality of thought is fostered and cultivated at the German Universities is an undoubted fact, but the requirements of the degree of Doctor of Philosophy cannot be entirely credited with this; it is rather that which is not required which is so advantageous to students. It is the *Lehre und lern Freiheit* which professors and pupils both enjoy; the professor has time for thought, and is not hampered by having to consider whether that which he teaches must be a suitable preparation for the pupils' various examinations, while the student, on the other hand, is not harassed by having to devote time and attention to uncongenial studies.

On the Continent the motive for scientific education is mental culture, while in Britain it is utilitarianism; while the former tends to the *advancement of learning*, the latter involves nothing further than the *diffusion of knowledge*. Hence the utilitarian principle neutralises in a great measure the advantages of an increased number of colleges, improved laboratories, and possibly of money-grants in aid of research.

The debased utilitarian view of the advantages of studying science is spread throughout the whole of this address, and it would be deplorable if all the presidents of the learned societies

[1] Bacon says ("Aphorisms," Book I. xc): "Again, in the habits and regulations of schools, universities, and the like assemblies, destined for the abode of learned men and the improvement of learning, everything is found to be opposed to the progress of the sciences.

preached an annual sermon from the same text. It is certain that the sympathies of the public would be alienated; and if those hearers who are taken to task were to follow consistently the lesson inculcated, they would occupy themselves entirely with objects of pecuniary gain instead of providing the discoveries which our manufacturers are so much in need of, or advancing learning by their contributions to the *Philosophical Transactions*.

W. N. HARTLEY

Our Future Watches and Clocks

IN reference to the note on this subject in NATURE (p. 36), it appears to me that to any radical change in dial-division there exist many objections, of more or less weight, over and above those already enumerated. In regard to—

(*A*) *Striking the hours.*—(1) It is said that "public clocks . . . could not go on to twenty-four." The same would apply to private clocks as well, as the higher numbers would be struck during the—to children and many others, sick or well—early hours of sleep, when greater disturbance from house clocks than at present occurs would be quite unendurable. The counter-advocacy of silent house clocks would scarcely meet the case.

(2) The alternative suggestion of "one stroke only at each hour" would do away with one important function of public clocks, that of marking to watchless people the exact hour. Persons abed, lonely watchers, and field-labourers, commonly depend upon the church clock for information which could only be acquired otherwise with much discomfort.

(*B*) *The* 24-*division plan.*—(3) That no diminution in "the angular motion of the hand" during any given time should be brought about seems most vital. The time of day is often obtained from far-distant clocks, and is even at present not easy to decipher readily, especially under circumstances of inadequate ight or visual power.

(4) Similarly, in the case of any slight looseness in the hands—a commonly-neglected chronometric infirmity—it would be harder than ever to decide at a glance what hour is indicated.

(5) It will be observed that the adoption of this plan would almost necessitate half-minute arcs.

C) *The double* 12-*division plan.*—(6) Inasmuch as the presence of two concentric circles of figures of undiminished size would shorten the clear effective length of the hands, the arc subtended by the hourly angle would be diminished by much the same extent as in the previous plan (*B* 3), and a similar objection would apply.

(7) The presence, in any form, of twenty-four symbols, in addition to the maker's name and the like, in the dial area, especially in ladies' time-pieces, would be eminently confusing, and restrictive of instantaneous decision as to what the time may be.

8. Even if, to obviate all this—a point suggested by the statement that "persons probably pay small attention to the figures"—a single circle of twelve conventional symbols, identical or not, such as a radial arrowhead, were adopted to indicate the a.m. and the p.m. hours in their turn, one would have to undergo the added mental labour of deciding the actual *number* of the hour.

(9) In any case the introduction of a "0" hour, unless we are to adopt railway phraseology, would be most awkward, and in the "double 12-division plan" the transition at noon and midnight from one circle to the other would not be a simple sequence.

Finally, the question arises whether the now common time-pieces, in which the hands are either replaced or supplemented by a series of peep-holes, wherein the minute, hour, and even week-day for the time being, are consecutively displayed, would not aid the introduction of the twenty-four hour system into rough general use. The main disadvantage of abolishing the hands is that one would lose an actual picture suggestive of the time which will elapse between the present and any point in the near future. For all purposes for which closer chronometric accuracy is required, the above stumbling-blocks to change in dial-division, arising out of the pressing value in ordinary life of the ability to tell the time swiftly, and without undue mental effort, would be swept away.

ERNEST G. HARMER

88, Buckingham Road, N., November 19

As regards the practical question how clocks are to be made to strike if the dial is to show twenty-four hours, I have a suggestion to make.

But firstly, the convenience of beginning the day at midnight is evident, as the early morning hours are those which it is most useful to have indicated to the ear, and our clocks may continue to strike from 1 a.m. to 6 as now.

The inconvenience of having to count any number of strokes above six is so great, and doing it so tedious, that most persons break down in attempting it with a slow-striking clock; and I think that there is a good deal to be said for the system, which obtains in some places where the hours are still reckoned as twenty-four, of beginning afresh at the end of every six hours, and denoting 7 and 13 as 1, &c. This plan would make very little or no change.

But what I wished to suggest is: That clock-makers should make the clocks to beat the strokes in pairs; *e.g.* two strokes and a rest + two strokes and a rest + one stroke, would be 5. This would be counted as easily as 3. Moreover, there would be no occasion under ordinary circumstances to count the strokes at all; whether the hour was *odd* or *even* would be all it was necessary to learn for one to know which hour it was of the twenty-four. One may, for instance, in the morning doubt whether it is 10 or 11, or whether it is 11 or 12, but one rarely doubts whether it is 10 or 12. And on the principle I recommend, the last stroke of the clock being single or double would decide the matter. One would not even have to attend to it. I contend that under the present system it is impossible for a person with only ordinary patience to discover whether a clock strikes 11 or 12.

If you think anything of this suggestion, which I have always thought myself to be a fair solution of a difficulty, I shall be glad if you would insert it in your paper.

R. B.

Lightning-Conductors

IN the *Edinburgh Review* of last July many of your readers will probably have noticed an article on "Lightning-Conductors," written somewhat strongly from the point of view of an advocate of the apparatus thus popularly designated. Perhaps a few words of comment on this paper from a rather different aspect may not be without interest to those who are able and willing to treat the subject with unprejudiced minds.

In the reviewer's narrative of the history of lightning-rods he omits all mention of Franklin's initial letter of September 1, 1747—that letter in which the great discovery of the power of points is given to the world. But it is abundantly evident from his subsequent letters of 1749 and 1750, in which he definitely forecasts the invention of rods, that it was to his knowledge of this power—and of this power alone—that he owed the idea of these instruments. In other words, his original conception was purely that of an apparatus for *preventing* the occurrence of a lightning-stroke at the place where the rod was erected. Now, if I am not mistaken, the reviewer from first to last never alludes to this all-important function. It is true that Franklin himself afterwards fell in with the curious supposition that these rods acted as "conductors" of a stroke. But (so far as can be judged from his letters) this was not till September 1753, at which time most of the European scientific men, themselves either ignorant or sceptical of the preventive power of points, had fully adopted the invention and had invested it with the theory, that has ever since been accepted, of its being a means of "conducting" past the building a stream of fiery matter (denoted as "electric fluid") descending from the clouds to the ground. Now it is evident that nothing can conduct the agency known by us as "lightning" without first being struck by it; and it is also manifest that, in order to be so struck, an object must present some "attraction" to the stroke. This attraction—this necessary first step to conduction—allowing for the nonce that an explosion such as constitutes a lightning-stroke *can* be conducted—is a matter that usually (and not unnaturally) is treated by those who believe in lightning-rods with some little reticence. I therefore think it is but fair to give credit to the reviewer for the open and honourable manner in which he enunciates his views of the true function of lightning-rods. He says (p. 40):—"Conductors provided by engineering art are *intended* to be struck, but struck in such a manner as to govern the lightning and to render the heaviest strokes harmless." There is no beating about the bush. He admits that his conductors are purposely fixed on a house in order to attract a stroke to that house with the view of afterwards rendering the effects of the explosion nugatory. Now the very essence of the opposition that has been made to the use of these conductors lies in this very fact of

attraction—and in one other fact, which is this. It is absolutely impossible to prove that *any stroke at all* would have occurred at the house if the attractive conductor had not been present. Granted, we (opponents) say, that your conductor, if in good order, *may* be the means of averting the terrific force of the explosion from the non-conducting materials of the building when once the stroke has been developed, we nevertheless prefer that our houses should receive *no stroke at all*. We infinitely prefer to run the extremely unlikely chance of ever being visited by a lightning-stroke to the practice of deliberately inviting such a stroke to our houses, and of trusting to the excellence of the rod-manufacturer's arrangements to avert any portion of its effects from the inmates and the structure.

Holding, then, as we do, that the principle of the lightning-rod, *quâ* its necessary exposure of additional elevated metal on a building, is vicious, and that nothing of a beneficial nature due to the preventive power of its point (if it have one) can obliterate this dangerous tendency, the undoubted disadvantages of the system, due to the defects in practice that habitually accompany the employment of rods, appear to be minor points. But the reviewer's reasoning on this branch of the subject is worthy of remark. He says (p. 52): "The failures incident upon defective work—as all unbiased and properly-trained thinkers are aware—are amongst the weightiest of the arguments that tell in favour of the employment of conductors." This sentence is wholly beyond my own reasoning power. Because (*cæteris paribus*) an apparatus is liable to failure on account of being defectively constructed, *therefore* it should be employed! He goes on to say:—"In a very large majority of the cases in which accidents have occurred to buildings which have been furnished with lightning-conductors the mischief has actually been traced by competent inquiry to some easily recognised fault or deficiency of construction." Allowing that even in *all* cases in which these disasters had occurred this statement were true, what does it show? Why, simply the very cheap sort of perception known as *wisdom after the event*. The manner in which, after the blow has happened, ingenious excuses are constantly made for the unfortunate conductors, which previous to the event had never been found fault with, is to the opponents of rods one of the most amusing and least edifying circumstances that environ the use of these instruments. But I would now venture to submit a few statistics derived from researches specially made by me during the last five years in regard to strokes and accidents in connection with lightning-rods. Up to date I have collected the fullest details of 320 well-authenticated cases. In 204 of these, or 64 *per cent.*, injuries either to rods, constructions, or persons, occurred. In 151 cases, or 47 *per cent.*, there were injuries either to constructions or to persons. Out of these 151 incidents, 71 contain in their records no allegations as to the existence of faults, either in the rod or in its "earth," until *after the event*, and the remaining 80 furnish no record of such faults being found *either before or after the event*. And indeed the whole of the results of my researches afford evidence (and especially in regard to the "earths" of rods) that failures and accidents more frequently happen with rods in what is deemed good order, than with those considered after the event to have been in bad order.

The reviewer in his enthusiastic advocacy of lightning-rods advises his followers not to be content with single, or even a few, rods on their houses, but to cover them with "a broadly-cast net of metallic meshes and lines." And he concludes with the following sentence:—"The free and frequent use of the testing galvanometer is the natural consummation of the beneficent work which was initiated by Franklin 130 years ago. Without this instrument the lightning-conductor is a hopeful and very generally helpful expedient. But with the galvanometer it is now assuredly competent to take rank as a *never-failing protection*." These *dicta* aptly conform with the reviewer's tactics in respect of the practical question of the *cost* of lightning-conductors. Here again, as in the case of the preventive power of points, he never mentions the subject. He seems to think that persons of common sense are capable of throwing "a broadly-cast net of metallic meshes and lines" of the purest copper over their houses, and of entertaining at frequent intervals the services of electrical testers to attend to these meshes and lines, without first counting the cost. He is perhaps unaware that (according to Sir William Thomson) the Glasgow manufacturers think it cheaper to insure their factories rather than to employ lightning-rods. But surely in regard to the statement that the use of the galvanometer makes the lightning-conductor a "never-failing protection," there is some little obscurity in the premises and conclusions. It is well known that rod advocates recommend the use of the galvanometer principally in order to test the resistance of the rod's "earth." If this resistance should prove to be above a certain standard, they say that the rod is not only useless, but dangerous. How is the mere fact of the *knowledge* that a rod is useless, or that its earth-resistance is too great, a "never-failing protection"? And what remedial measures can possibly obviate the dryness of the ground? One might as well say that the services of a physician who, having tested his patient's state of health, should tell him that he was in a bad way, and should then dismiss him, constituted a "never-failing protection." In the case of the rod the only protective feature appears to me to lie in the probability that most persons who were also "unbiased and properly-trained thinkers," on being informed that the galvanometer had demonstrated their rods to have a too great "earth" resistance, would immediately pull them down. But obviously this is hardly the reviewer's meaning. ARTHUR PARNELL

53, Fulham Park Gardens, November 17

Government Scientific Books

SHORTLY after the commencement of the publication of the "Scientific Results of the Voyage of H.M.S. *Challenger*" by the Government, the late Mr. T. C. Cobbold, M.P. for Ipswich, inquired in the House of Commons whether, inasmuch as this expedition was undertaken with the nation's money for national scientific purposes, a copy of the volumes as published would not be presented to the public libraries supported by public rates, &c. The Government reply was that the expense of supplying the work gratis to such libraries in the different towns throughout the country would be too large.

I should like to ask whether it would have cost anything like the 87,500*l.* which the Government has recently paid for only two pictures from the Blenheim collection, and whether the ratepayers throughout the country have not a far greater right to be supplied (through their libraries) with the opportunity of seeing and studying the results of their own scientific expeditions than the remote opportunity of seeing these two 87,500*l.* paintings at Kensington.

I see by your advertisement that the tenth volume, at 50*s.*, of the "*Challenger* Reports" is just published. What chance have thousands like myself of ever seeing them. Our public museum library cannot afford to purchase them, though I have little doubt but that our town, with its 50,000 inhabitants, has more than paid for a copy of the Reports in its share towards the expense of the Expedition and the publications resulting therefrom.

As a country ratepayer I must protest against this centralisation of all the great works in art and the benefits and results of scientific expeditions in London. Some of your correspondents have complained that such *national publications* are not supplied to great national libraries abroad, but how is it that even we who have had to pay for them cannot ever get a sight of the results of such interesting and important national scientific expeditions. "Cannot afford it" is the Government reply, but how then can they afford 87,500*l.* for two paintings for the national galleries? I do not grudge the expenditure of the people's money for the latter, only when set off against the "cannot afford" for the former. W. BUDDEN

Ipswich, November 18

P.S.—I have the two volumes of Sir C. W. Thomson's "Voyage of the *Challenger*," but they have only tended to create a greater desire to see the complete "Government Reports," a wish, alas, which, from the expenditure of the 87,500*l.* for pictures by the Government, is further off than ever.

Peculiar Ice Forms

ABSENCE from town prevented me from seeing NATURE of November 6, in which there is a letter (p. 5) signed B. Woodd Smith with the above heading.

Possibly Mr. Smith's very ingenious explanation of the cause of the columnar form of the shallow stratum of ice he so well describes may be the correct one; yet perhaps I may be permitted to offer a very different solution of the difficulty connected with this very curious ice formation.

I have frequently noticed, both on lakes having deep water

and on those so shallow as to freeze to the bottom, that when the winter ice had nearly all thawed away, the remaining ice assumed the basaltic or columnar form, which on the deep-water lake could be walked over with perfect safety in the early morning, being then perhaps six or eight inches thick, and apparently quite solid, but which all disappeared a few hours afterwards in a magical manner, the columns having become very rapidly detached, especially if there was a fresh breeze, and, falling over on their sides, became invisible, and drifted to the lee side of the lake. This often led to a very general but wholly erroneous belief that the ice had *sunk*.

The question may be very naturally put: What has all this to do with "peculiar ice forms" on dry land?

The foregoing particulars are mentioned to show that ice in wasting away assumes not unfrequently the basaltic form.

I believe that the bank on which the peculiar ice was noticed by Mr. Smith, and described by him as bare of vegetation, is usually covered in winter by a deep snowdrift, and that, towards spring and later, pressure and the percolation of water from the thawing surface converts the lower stratum of snow—still colder than the freezing point—into ice. May not this ice, when nearly all wasted away, assume, as it does on the lakes, a basaltic structure?

May not the division of this four inches of ice "into four distinct layers—the columns of one layer being readily detached from those underneath"—be accounted for by what I have found to take place in snowdrifts, as I shall attempt to explain.

In building snow-huts there are two requisites essential for perfection in this kind of architecture. First, the snow has to be packed so firmly by the force of the wind as to be hard enough to walk over without sinking in it; secondly, the required depth of from fifteen to sixteen inches must be the formation of one and the same snowstorm and gale of wind. If this is not so, and the required depth of fifteen inches has been the result of three separate snowstorms, the blocks of snow, when sawn out, would not cohere, but break into three narrow strips of four or five inches each, which would render hut-building in the proper *artistic* manner and with rapidity (an important point in very cold weather) impossible.

These separate layers of ice noticed by Mr. Smith may possibly be the small remains of four separate and distinct snowstorms piled one above the other, which I know do—whilst in the form of snow—retain their individuality for the whole winter, although super-imposed the one upon the other.

The layer of "dirt" which Mr. Smith, from his point of view, very naturally supposes to be evidence that the mass of "peculiar ice" was pushed up from below, may be very easily otherwise accounted for.

In all gales with drifting snow in the Arctic, especially when there are high steep lands to be passed over, part of the ground is cut away by the driving snow in the form of fine powder or dust, and is carried sometimes a long way until deposited with the snow in some sheltered part.

This dust is small in quantity as compared with the bulk of snow, and is scarcely discernible when mingled with it; but when greater part of the snow melts, the dust shows as a very perceptible coat of "dirt" on the surface, which I consider has come down from above instead of being "pushed up from below" out of the ground as Mr. Smith believes to be the case.

4, Addison Gardens, Kensington, W. JOHN RAE

Fly-Maggots Feeding on Caterpillars

IN reply to Dr. Bonavia's note on the above subject in NATURE for November 13 (p. 29), I beg to inform him that the larvæ of the house-fly are often internally parasitic on the larvæ of Lepidoptera. I have bred them in large numbers from *Vanessa io* and *Saturnia carpini*, also from other species more sparingly. Nor is this the only species of Diptera that infests Lepidoptera. F. N. PIERCE

143, Smithdown Lane, Liverpool

Birds'-Nest Soup

IN NATURE of July 17 last (vol. xxx. p. 271), just received, appears an article on "Birds'-Nest Soup," which contains the statement that "the nests of the *bats*[1] and swifts were seen hanging in clusters from the sides and roof." That the addition of the "*bats*" to the contributors of the nests is not an accidental *lapsus calami* is shown further on, when we read that the visitor eating the soup will "at any rate have the satisfaction of knowing that he has before him a dish the principal ingredient of which was formed by the little swifts *and bats*[1] which inhabit the Gomanton Caves," &c., &c.

[1] The italics are mine.—E. L. L.

I too have visited caves from which large quantities of edible birds' nests were collected. I saw plenty of *bats*, but, unfortunately, none of their nests! The nests *I saw* were built by a "swiftlet" (*Collocalia*, Gray), and were more or less the *product of their own salivatory glands*. This fact was known as far back as 1781, over one hundred years ago!! The "*white nests*" are supplied entirely by the inspissated saliva of the bird, and are the first produced. These are taken, and sold for their weight in silver. The next made by the birds are mixed with rootlets, grasses, &c., and often show traces of blood, from the efforts of the birds to produce the saliva. These are esteemed second quality. The third nest is composed of extraneous substances cemented together and to the rock with a little saliva; these are generally left for the bird to breed in, and are usually destroyed at the end of the season to compel the birds to build fresh *white* ones after their powers are recruited by a year's rest and stimulated by the breeding "*storge*."

All this genus—the swiftlets (*Collocalia*)—wherever found, produce, in a greater or less degree, an amount of saliva which is used in building their nests and attaching them to the surfaces of rocks or the insides of hollow trees and leaves. The properties in this *saliva*—as in the *kava* of the Fijians and the *pepsine* of the calf—give it its value in the eyes of the Chinese. If it were simply a "fungoid growth" woven together, why is it not gathered from the limestone rock in its pure state?

British Consulate, September 17 E. L. LAYARD

THE PRIME MERIDIAN CONFERENCE

WE believe that the protocols of this Conference have not yet reached this country. In the meantime we are permitted to give the official statement of the resolutions.

FINAL ACT

The President of the United States of America, in pursuance of a special provision of Congress, having extended to the Governments of all nations in diplomatic relations with his own, an invitation to send Delegates to meet Delegates from the United States in the City of Washington on October 1, 1884, for the purpose of discussing, and, if possible, fixing upon a meridian proper to be employed as a common zero of longitude and standard of time-reckoning throughout the world, this International Meridian Conference did assemble at the time and place designated; and, after careful and patient discussion, has passed the following resolutions:—

I. "*Resolved*, That it is the opinion of this Conference that it is desirable to adopt a single prime meridian for all nations, in place of the multiplicity of initial meridians which now exist."

This resolution was unanimously adopted.

II. "*Resolved*, That the Conference proposes to the Governments here represented the adoption of the meridian passing through the centre of the transit instrument at the Observatory of Greenwich as the initial meridian for longitude."

The above resolution was adopted by the following vote:—

In the affirmative—

Austria-Hungary,	Mexico,
Chili,	Netherlands,
Colombia,	Paraguay,
Costa Rica,	Russia,
Germany,	Salvador,
Great Britain,	Spain,
Guatemala,	Sweden,
Hawaii,	Switzerland,
Italy,	Turkey,
Japan,	United States,
Liberia,	Venezuela.

In the negative—

San Domingo.

Abstaining from voting—

Brazil,	France.

Ayes, 22 ; noes, 1 ; abstaining, 2.

III. "*Resolved*, That from this meridian longitude shall be counted in two directions up to 180 degrees, east longitude being plus and west longitude minus."

This resolution was adopted by the following vote :—

In the affirmative—

Chili,	Liberia,
Colombia,	Mexico,
Costa Rica,	Paraguay,
Great Britain,	Russia,
Guatemala,	Salvador,
Hawaii,	United States,
Japan,	Venezuela.

In the negative—

Italy,	Sweden,
Netherlands,	Switzerland.
Spain,	

Abstaining from voting

Austria-Hungary,	Germany,
Brazil,	San Domingo,
France,	Turkey.

Ayes, 14 ; noes, 5 ; abstaining, 6.

IV. "*Resolved*, That the Conference proposes the adoption of a universal day for all purposes for which it may be found convenient, and which shall not interfere with the use of local or other standard time where desirable."

This resolution was adopted by the following vote :—

In the affirmative—

Austria-Hungary,	Mexico,
Brazil,	Netherlands,
Chili,	Paraguay,
Colombia,	Russia,
Costa Rica,	Salvador,
France,	Spain,
Great Britain,	Sweden,
Guatemala,	Switzerland,
Hawaii,	Turkey,
Italy,	United States,
Japan,	Venezuela.
Liberia,	

Abstaining from voting—

Germany,	San Domingo.

Ayes, 23 ; abstaining, 2.

V. "*Resolved*, That this universal day is to be a mean solar day ; is to begin for all the world at the moment of mean midnight of the initial meridian, coinciding with the beginning of the civil day and date of that meridian, and is to be counted from zero up to twenty-four hours.'"

This resolution was adopted by the following vote :—

In the affirmative—

Brazil,	Liberia,
Chili,	Mexico,
Colombia,	Paraguay,
Costa Rica,	Russia,
Great Britain,	Turkey,
Guatemala,	United States,
Hawaii,	Venezuela.
Japan,	

In the negative—

Austria-Hungary,	Spain.

Abstaining from voting—

France,	San Domingo,
Germany,	Sweden,
Italy,	Switzerland.
Netherlands,	

Ayes, 15 ; noes, 2 ; abstaining, 7.

VI. "*Resolved*, That the Conference expresses the hope that as soon as may be practicable the astronomical and nautical days will be arranged everywhere to begin at mean midnight."

This resolution was carried without division.

VII. "*Resolved*, That the Conference expresses the hope that the technical studies designed to regulate and extend the application of the decimal system to the division of angular space and of time shall be resumed, so as to permit the extension of this application to all cases in which it presents real advantages."

The motion was adopted by the following vote :—

In the affirmative—

Austria-Hungary,	Mexico,
Brazil,	Netherlands,
Chili,	Paraguay,
Colombia,	Russia,
Costa Rica,	San Domingo,
France,	Spain,
Great Britain,	Switzerland,
Hawaii,	Turkey,
Italy,	United States,
Japan,	Venezuela.
Liberia,	

Abstaining from voting—

Germany,	Sweden.
Guatemala,	

Ayes, 21 ; abstaining, 3.

Done at Washington, October 22, 1884.

C. R. P. RODGERS, Rear-Admiral U.S.N., *President*,
L. CRULS (Brazil), JANSSEN (France), R. STRACHEY (Great Britain) . . . } *Secretaries.*

"*Resolved*, That a copy of the resolutions passed by this Conference shall be communicated to the Government of the United States of America, at whose instance and within whose territory the Conference has been convened."

ON THE INTERFERENCE-CURVES KNOWN AS "OHM'S FRINGES"

PERHAPS I may be allowed to recall the attention of physicists to the above "strange and interesting phenomena," as they are rightly called by their discoverer, Prof. G. S. Ohm (see *Pogg. Annalen* for 1853, vol. xc. p. 327) ; partly for the purpose of indicating a simple method of observing them.

According to Prof. Ohm's directions two plates of equal thickness are to be cut from a uniaxial crystal, with parallel surfaces making an angle of 45° with the optic axis. One of these plates is to be placed on the other in such a position that the optic axes lie in the same plane but on opposite sides of the normal common to the two plates, with which they make, of course, equal angles of 45°. When this combination is held in a convergent beam of plane-polarised monochromatic light (*e.g.* yellow sodium light), numerous alternations of bright and dark elliptical bands are seen, most distinctly when the plane containing the optic axes makes an angle of 45° with the plane of polarisation of the light.

Of course a pair of "Savart's band" plates, when properly oriented, will answer for the above experiment ; but the peculiar double refraction of quartz causes more complicated but beautiful results.

Now, since in Iceland spar the optic axis makes an angle of very nearly 45° (strictly, 44° 36′) with the natural faces of the rhombohedron, all that is required is to obtain an even cleavage-plate of the spar, about 2 cm. × 1 cm. and about 2 mm. thick, to break it in half, to turn one of the pieces round in a plane parallel to its surfaces through an angle of 180° from its position when broken off, and to cement it on the other piece in this position with Canada balsam or dammar.

Then, on placing the combination in a polariscope (for instance, laying it on the eye-lens of a microscope with analyser just above it) the series of ellipses will be well seen. Sodium light, *e.g.* that from a Bunsen burner with a bead of sodium carbonate held in the flame, must be used.

Prof. Ohm refers to a paper by Langberg (which I have not been able to get a sight of) in which the occurrence and form of these bands were predicted from theory; so that the case resembles those of Airy's spirals and Hamilton's conical refraction.

A pair of plates with surfaces making an angle of 70° (or more) with the optic axis also show these ellipses; and perhaps more instructively, since with such plates it is easy to trace the origin of the bands in the coalescence of portions of the circular isochromatic bands of high order which surround the optic axis in each plate.

Those who have a pair of Savart's plates mounted so that one can rotate over the other, will find it most interesting and instructive to watch (in monochromatic light) the changes in form and character of the interference-bands as the azimuth of one of the plates is gradually altered.

Eton College H. G. MADAN

CONTINUOUS AUTOMATIC BRAKES

THE returns of the Railway Department of the Board of Trade serve as an excellent index to the defects in the management and working of the railway system in this country, the defects being brought to light during the investigations of the trivial casualties and disastrous accidents which take place, and inquired into by the experienced inspectors of the Board of Trade.

It is evident that by far the greater number of accidents seem to have been caused by the trains not being fitted with a really good brake, and in consequence being unable to stop quickly in cases of emergency. Some even have been caused by the brake itself failing to "go on" when required, caused either by some defect in the brake mechanism, or the design of the brake itself has been bad, giving the engine-driver a false sense of security, and leading the train with its living load into unnecessary danger.

It is a pity the railway companies do not pay more attention to the conditions laid down by the Board of Trade with regard to continuous brakes, stating the qualities the brake ought to possess, for it is evident the Board does not wish the adoption of any particular patentee's brake, but a brake which includes to the fullest extent the conditions laid down. It so happens that the Westinghouse automatic brake answers the conditions better than any other, and therefore the Board is anxious to see it in general use, not because an ex-inspector of the Board happens to be the chairman of the English Westinghouse Brake Company, as the secretary of one English railway seems to imagine, but because it is the best brake.

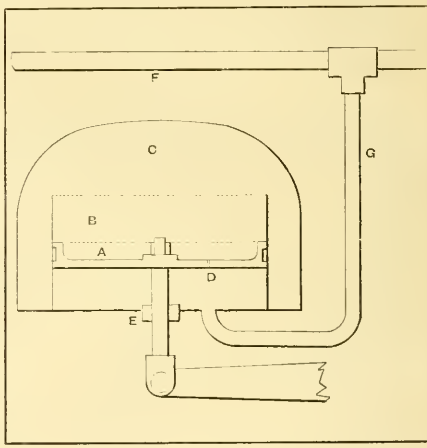
In an extract from the Board of Trade returns on continuous brakes for the half year ending June 30, published by the Vacuum Brake Company, we find the Westinghouse automatic credited with 397 faults for a mileage of 15,506,447.

We think it may be truly stated that the Westinghouse automatic has not had fair play with some of the companies having it partially in use, its failures having been carefully reported, while any failure of their own special brake, not having any serious consequences, has been looked over.

Take for instance the returns sent in by the Midland Company. Here the Westinghouse automatic has failed thirty-seven times for a mileage of 374,390, or one fault for every 10,118 miles, while the Midland automatic vacuum has six failures reported for a mileage of 5,245,573, or one fault for every 874,262 miles run. On the other hand we have the London, Brighton, and South Coast Railway using the Westinghouse automatic on the whole of their trains; they report seventy-four failures for a mileage of 3,122,510, or one fault for every 42,196 miles run.

Why should the Westinghouse automatic run four times as many miles per failure on the Brighton line than on the Midland? The reason is not far to seek; on the Brighton line the Westinghouse automatic is properly looked after, and kept in good repair, while on the Midland it has to stand back and give place to the vacuum automatic, the Company's brake.

The automatic vacuum brake in use on the Midland Railway has, as its name implies, the pressure of the atmosphere opposed to a partial vacuum for its motive



power, the vacuum being created by means of an ejector on the engine, connected to every vehicle on the train by means of a continuous pipe, having flexible pipes and couplings between the vehicles. To maintain the vacuum throughout the train against leakage, there is a small ejector continually in use on the engine.

Coupled to the continuous pipe on each vehicle is the automatic brake cylinder and reservoir peculiar to the Midland automatic brake, the piston being connected by means of levers and rods to the brake-blocks. The illustration gives a good idea of the general construction of the brake-cylinder and its connections, the arrangement being as follows:—The brake-cylinder B is placed inside the reservoir C, the piston A working air-tight in the cylinder; the piston-rod passing through the bottom of the cylinder by means of a gland, E, having a flexible packing ring. so arranged that when the piston is at the bottom of the cylinder it comes in contact with the packing ring, making an air-tight joint; but when the piston moves upwards, leaving the packing ring, air is able to pass through the gland into the lower part of the brake-cylinder. The continuous pipe F is connected by the branch pipe G to the lower part of the brake-cylinder.

Through the piston there is a small hole, D, called the leak-hole, this being one of the main features of the brake, the mode of action of which is as follows:—A vacuum is created in the continuous pipe by means of the ejector on the engine, the air being drawn from below the pistons in the brake-cylinder by the branch connections; the air in the reservoir C leaks through the leak hole D, and after a short time there is an equal vacuum above and below the pistons. The brake is now charged, and in its usual condition when the train is running, the vacuum being maintained against acccidental leakage by the continual use of the small ejector.

To apply the brake, air is admitted into the continuous pipe, destroying the partial vacuum, and, increasing the pressure below the pistons, causes them to rise, breaking at the same time the air-tight joint made by the piston against the packing ring, thereby admitting air *direct*, through the gland, into the lower part of the brake-cylinder, causing the application of the brakes to be nearly instantaneous. It will be observed that, directly the piston is forced up by the atmospheric pressure, the vacuum in the reservoir will gradually be destroyed by air passing through the leak-hole, in fact after less than two minutes it has leaked itself entirely off. It is also evident that it cannot be instantly charged, for the vacuum in the reservoir has to be created through the leak-hole.

It is stated by some that the Midland automatic vacuum answers all the Board of Trade conditions, and is therefore to be regarded as an effective serviceable automatic brake. On studying the reports in the returns, and the failures of this brake as reported in the technical papers, we see how absurd the claim to efficiency becomes. For example, the brake cannot be applied *quickly* several times in succession; when applied even once, the effective brake power has all vanished in two minutes, thus getting the doubtful name of the "two-minute leak-off brake." Again, suppose a train became divided from any cause, when ascending a heavy gradient, the brake should automatically apply itself, and *remain applied* until taken off by hand. What would the Midland automatic vacuum do under the above circumstances? Certainly the brake would apply itself, but in two minutes or less all the available brake power will have vanished, and, should the hand-brake in the rear van not prove powerful enough to hold the train on the bank, it will commence to run back.

Although the Midland Company have the automatic vacuum in general use, it is no criterion that the brake is satisfactory; we have only to add that the engines and tenders are fitted with an efficient steam brake, so that in entering stations, should the automatic vacuum fail, the steam brake is quite capable of stopping the train, only taking a little further distance to pull up in. At terminal stations sometimes this is very awkward, as the accident at the Liverpool Central Station, which happened some time ago, shows. Here the automatic vacuum brake failed, and the train ran into a brake-van standing by the stop-blocks, doing considerable damage. Reports of failures of the Midland automatic vacuum may be seen almost weekly in the "Railway Matters" column of the *Engineer*, and we give, as an example taken at random, one reported in the issue for October 17:—"As it is not very likely to be elsewhere recorded, it may be here mentioned that on the 10th inst. a twelve-coach Midland Scotch express ran clean through Bedford station before it was stopped, in consequence of the failure of the leak-off vacuum brake." Such failures are highly dangerous, and any brake with which they are likely to occur cannot be efficient, and therefore ought not to be trusted to stop trains at any important junction or station, and its use absolutely prohibited on approaching a terminal.

It may be interesting to have a short account of the Westinghouse automatic pressure brake, the worst fault of which, according to its opponents, is its efficiency in stopping trains should anything go wrong with the brake apparatus. The motive power of this brake is compressed air at a pressure of about 80 lbs. to 100 lbs., compressed by an ingeniously constructed steam-pump on the engine, and stored in a main reservoir under the foot-plate; throughout the train runs a pipe, connected between the vehicles by means of flexible hose pipes and couplings. On each vehicle, including the engine, is placed a small reservoir, a triple valve, and a brake cylinder, with a piston connected by levers and rods to the brake blocks. On the engine is placed the driver's brake-valve for working the brake. The whole system of this brake lies entirely in the construction and action of the triple valve. When the brake is in use, the train-pipe and small reservoirs are charged with compressed air, the air passing through the triple valve in its passage from the train-pipe to the small reservoirs. On the air-pressure being reduced, the triple valve opens a passage between the small reservoir and the brake-cylinder, thus allowing the compressed air stored to expand into the brake-cylinder, forcing out the piston, and applying the brake. To take the brake off, the converse happens: the pressure in the train-pipe is increased, the triple valve closing the passage between the small reservoir and the brake-cylinder, at the same time allowing the compressed air in the brake-cylinder to exhaust into the atmosphere, the small reservoir again being charged with compressed air from the train-pipe.

The triple valve consists of a small cylinder having a piston connected on the upper side to a small slide-valve working over two ports, arranged one about the other, the lower opening direct to the atmosphere, the upper connected by a pipe to the brake-cylinder. The slide-valve works in a small casing connected to the small reservoir; the triple valve is connected to the train-pipe by a pipe opening into the lower part of the cylinder in which the small piston works. When the piston is at the top of the cylinder it opens a connection between its lower and upper side, thus allowing compressed air to pass round the piston into the casing in which the slide-valve works, then into the small reservoir. When in this position, the slide-valve has closed both ports to the compressed air in the casing, the port leading to the brake-cylinder being open, through the valve, to the lower or exhaust port.

On charging the train-pipe with compressed air it will be observed that the piston in the triple valve will be forced up, thus filling the small reservoir and triple valve with compressed air, but *not* the brake-cylinder; also that the pressure of air on both sides of the piston in the triple valve will be equal; on reducing the air-pressure in the train-pipe by a few pounds, the piston will naturally be forced down, by the greater pressure on the upper side moving the slide-valve and allowing a quantity of the compressed air in the small reservoir to enter the port leading to the brake-cylinder, and apply the brake.

The air expanding into the brake-cylinder will cause its pressure to be reduced, and therefore balance the piston in the triple valve. It is evident therefore that any small reduction of pressure in the train-pipe will cause a corresponding application of the brake, a reduction of the pressure by 25 lbs. being sufficient to put the brake hard on and skid every wheel.

The function of the driver's brake-valve is to work the brake-apparatus by varying the pressure of the air in the train-pipe. In the first position of the handle which works the valve, called the charging position, air from the main reservoir is able to go direct to the train-pipe, to charge or release the brake. On moving the handle through an angle of a few degrees into the feed-position, the connection between the main reservoir and the train-pipe is closed, the compressed air having to pass through a pressure-reducing valve on its way to the train-pipe from the main reservoir to make up for any slight leakage which may occur.

It is important that the pressure of the air in the main

reservoir should always be about 15 lbs. above that in the train-pipe, so that when the brakes are being released by increasing the pressure in the train-pipe *direct* from the main reservoir, the triple valves are certain to act, on account of the extra 15 lbs. pressure in the train-pipe above the pressure in the small reservoirs.

On moving the handle of the driver's valve further in the same direction, or into the position for applying the brakes, all connection between the main reservoir and the train-pipe is cut off, at the same time that the train-pipe is put in connection with the atmosphere, through an exhaust port; by this means the pressure in the train-pipe can be reduced to any degree to apply the brake. All brake-cylinders on vehicles are fitted with a release-valve, so that, should the brake be applied when the engine is not attached, the air can be discharged from the brake-cylinder, through the release-valve, by pulling a wire attached to the valve.

All vehicles now fitted with this brake have cocks at each end of the train-pipe, so that, should any change have to be made in the train, the coupling or uncoupling of vehicles is easily accomplished without the brake automatically applying itself.

It is easy to see that this brake is automatic in its action, for should the train-pipe or flexible couplings be injured by accident, or the train part into two or more portions, the compressed air will escape from the train-pipe, and the brake will apply itself. In all guards' vans is placed a cock in connection with the train-pipe, so that, should the guard observe anything wrong with the train, or receive a signal from a passenger, he can instantaneously apply the brake by opening the cock and discharging the air from the train-pipe.

The Westinghouse automatic brake is at present the only one which really includes all the qualities in the Board of Trade requirements for continuous brakes, and perhaps it will not be out of place to state the requirements of the Board of Trade.

(1) The brakes to be efficient in stopping trains, instantaneous in their action, capable of being applied without difficulty by engine-drivers and guards.

(2) In cases of accident, to be instantaneously self-acting.

(3) The brakes to be put on and taken off (with facility) on the engine and every vehicle of a train.

(4) The brakes to be used in daily working.

(5) The material employed to be of a durable character, so as to be easily maintained and kept in order.

On looking through the Board of Trade returns on continuous brakes for the six months ending June 30, one sees that over two-thirds of the failures of the Westinghouse automatic are due to burst hose pipes alone, and therefore not failures of the brake itself, but of faulty inspection and bad material. We would like to hear of experiments being made with a stronger and more durable material, so as to resist the destructive action of the oil and tallow, of which such a large quantity is used on railways. Could this improvement be effected, we are convinced the number of miles run per failure would immediately vastly increase, leaving the automatic vacuum brake far behind. Of failures of the triple valve to act we find fifteen reports, causing a very trifling delay to the trains. The air-pump is reported with eleven failures, and the driver's brake-valve has no failures recorded against it. When we consider the enormous mileage of 15,506,447 miles run by trains fitted with the Westinghouse automatic for the six months ending June 30, we cannot help being astonished at the freedom from failure of the different parts, and the general efficiency of the apparatus.

Much has been written about the failure of the simple vacuum brake in the Penistone accident on the Manchester, Sheffield, and Lincolnshire Railway, the disaster being attributed by some to the brake failure alone. Certainly, had the train been fitted with the Westinghouse automatic, the brake power on each vehicle would have remained intact, no matter how many couplings broke: but at the same time the fact seems to have been overlooked that the train had no permanent way to run on, since the engine broke up the chairs as it advanced, and the question remains, How would the train have been affected, having nearly all the wheels locked by the brake, and running over sleepers alone? Perhaps the train would not have travelled so far before going over the embankment; but we think the disaster would have been equally serious, each vehicle becoming detached by the sudden application of the brake, the couplings breaking on account of the violent jerks in passing over the sleepers, the curve tending to throw the vehicles over the embankment. As an example of the life-saving qualities of an automatic brake in an accident, we think the Penistone disaster would have been a poor specimen.

The question of automatic *versus* simple brakes, both pressure and vacuum, is now fairly before the public, and the policy of the Board of Trade seems more apparent every day. It would not be wise on their part to enforce the adoption of any particular patent brake, for a better one may any day be discovered, but the Board may fairly insist that their conditions as to the qualities of any brake adopted by any Company should be complied with, and, if necessary, enforced by Act of Parliament.

THE GALVANOMETER OF D'ARSONVAL AND DEPREZ

GALVANOMETERS of innumerable kinds abound, and each form has some special merit which renders it useful for certain restricted services. The old astatic instrument of Nobili is still preferred by many to the more modern mirror galvanometer of Sir W. Thomson because it requires no lamp, and can be used without darkening the room. The tangent galvanometer still holds its own in the testing-room for simple tests; and the lineman's detector is still indispensable on the score of its portability. For commercial purposes, where strong currents and steady potentials have to be measured, the newer ampere-meters and volt-meters have displaced the older forms of instrument. But still there is no best galvanometer of universal adaptability, even the Siemens "universal" galvanometer being too clumsy to meet with general favour.

For the purposes of the private laboratory a galvanometer is desired which shall be sensitive, yet accurate in its indications, capable of being used for measuring currents of all kinds, weak and strong, and of measuring differences of potential from the thousandth of a volt to a thousand volts. It ought to be capable of being used in broad daylight; of being rapidly read off; and it ought also to be independent of external magnetic disturbances. The annoyances which arise from the last two causes when working with sensitive galvanometers are only too well known. The needle of the instrument once deflected continues to oscillate perhaps for half a minute, perhaps longer, causing vexatious delays, and when perhaps it has settled down at last to zero, some person in the next room moves a piece of iron—a poker, a penknife, or some other magnetic object—causing the zero of the instrument to change. An aperiodic dead-beat instrument, not subject to external magnetic forces, would be a boon indeed.

A galvanometer which, without being absolutely perfect, goes very near to fulfilling these desirable conditions has lately been put into the hands of electricians by M. Carpentier, of Paris, successor to the well-known Ruhmkorff. It is the invention of M. Marcel Deprez as modified and improved by Dr. d'Arsonval. The many novel features which it presents would of themselves justify its description in the pages of NATURE: and the general excellence

of its performance, of which the writer of these lines can personally testify, is already widely acknowledged.

The main peculiarity of the new instrument lies in the fact that, whereas in almost all galvanometers there is a fixed coil and a movable magnetic needle, in this galvanometer the coil is movable and the magnet—no longer a mere needle but a substantial compound horse-shoe of steel—is fixed. Fig. 1 represents the instrument itself. The steel magnet, made of three thin horse-shoes each magnetised as strongly as possible, is firmly fixed to a metal base, with its poles upwards. Between the poles hangs the coil, rectangular in form and extremely light, held in its place by a thin silver wire above and another thin silver wire below. This coil is made by winding on a rectangular core, which, after the strands have been cemented and bound together, is removed, leaving the wire only. It weighs only a few grains. To reinforce the magnetic field a small cylinder of soft iron, small enough to lie in the hollow of the suspended rectangular coil without touching it, is placed between the poles and is rigidly supported from behind. The coil is then free to turn in the very narrow space between the

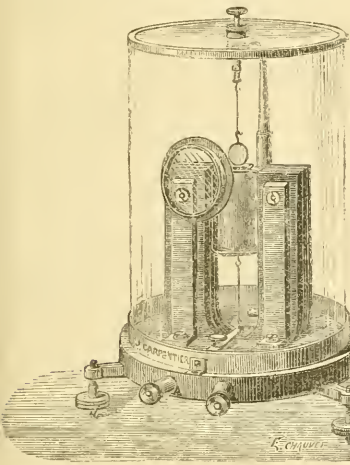


Fig. 1.

iron core and the external magnet-poles; and it need hardly be added that this contrivance produces a very intense magnetic field. The current is led in by one of the silver suspension-wires, and leaves the coil by the other. So far the arrangement precisely resembles that adopted in the well-known "siphon-recorder" of Sir W. Thomson, invented twenty years ago for the purpose of cable-signalling. A small mirror of 1 metre focus is affixed to the suspended coil; a brass spring at the bottom keeps the suspending wires adequately stretched; and a screw-head at the top of the instrument serves both to regulate the tension in the wires and to let the coil down, to a position of rest on the central iron cylinder, whenever the galvanometer is to be dismounted for removal to a distant place. The resistance of the coil is about 150 ohms in the ordinary pattern of instrument. As there is no suspended needle, no external magnetic forces affect the zero of the instrument; and, since the position of the coil is determined solely by the elasticity of the suspending wires and the magnetic action of the fixed magnet on the current in the coil, it can be used in any position, and is independent of the earth's magnetic field. It can even be placed quite near to a dynamo-machine. The intensity of the magnetic field in which the coil is situated is such that whenever the galvanometer-circuit is closed—even through a considerable resistance—the motion of the needle is dead-beat. It takes less than *one second* to come to rest at its final position of deflection, and when it returns to zero it does so with the most complete absence of oscillations. The spot of light on the scale never oscillates so much as 1 millimetre over the zero on releasing the galvanometer-key.

The optical arrangements adopted by M. Carpentier are shown in Fig. 2. The instrument is set with its three levelling screws in three V-grooves in a convenient bed-plate. Opposite it is set a semi-transparent scale of celluloid, 50 centimetres in length, graduated in millimetres. The light is provided by a single wax candle held in a holder like a carriage-candle, which also carries a paraboloidal mirror back. This candle is set so that its light falls upon a small adjustable plane mirror fixed to the back of the scale. This mirror reflects the ray upon the small mirror of the galvanometer, but as it passes beneath the scale it traverses a square aperture across which a thin wire is stretched vertically. To see the spot of light the observer stations himself in front of the scale, so as to see the light coming through the strip

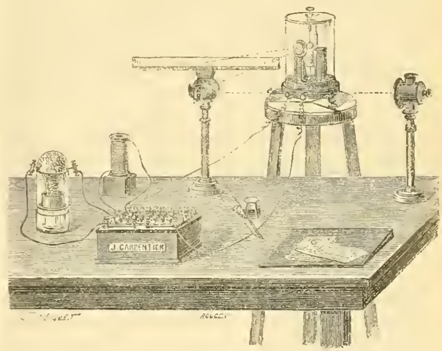


Fig. 2.

of celluloid. He sees a bright patch about 1 inch square having a single sharply-defined black line—the image of the aforesaid wire—down its middle. This patch of light and the central line are perfectly visible in broad daylight, but cannot be well seen by more than one observer at one time. The adjustment of the lamp and scale is a simple matter; and light from any lamp in the room—an overhead gas-light for example—may be used instead by turning the adjustable mirror to the proper angle.

When set up without any shunt, this galvanometer will show a deflection of 1 millimetre on the scale for about 1/100,000,000 of an ampere of current: but the sensitiveness differs in different instruments with the construction of the coil, the stiffness of the suspension, and the power of the magnets. Two instances of its application may be given.

The instrument can be applied as a volt-meter to measure the electromotive forces of cells in the manner indicated in Fig. 3. An ordinary reversing-key, K, is connected to the galvanometer, and an adjustable resistance (a Wheatstone rheostat with a thin wire having a range from 1 to 200 ohms is convenient) is interposed as a shunt, S. To calibrate the instrument a standard Daniell cell (E.M.F. = 1·07 volt) is placed at B in circuit with a resistance box. A resistance of 10,000 ohms is unplugged and a reading

is taken of the galvanometer, first to left, then to right, and the shunt-resistance is then adjusted until the scale reading is $53\frac{1}{2}$ millimetres on either side of zero, making a total of 107 millimetres. We then know that a deflection of 1 millimetre right or left will be produced by an electromotive force of 1/200 of a volt. The cell whose electromotive force is to be tested is then substituted at B in place of the standard cell, and readings taken right and left; these are added, and divided by 100, giving the E.M.F. of the cell directly in volts.

To measure currents the same calibration is made with a standard cell. In the circuit of the current to be measured is interposed a wire of some small but accurately-known resistance—for example, a standard 1 ohm, or, for stronger currents, a standard wire of 0·1 ohm. The two extremities of this coil are then connected to the key (Fig. 3), the 10,000-ohm coil being interposed as before. If the current to be measured is 1 ampere, it will, in passing through the standard 1 ohm, produc

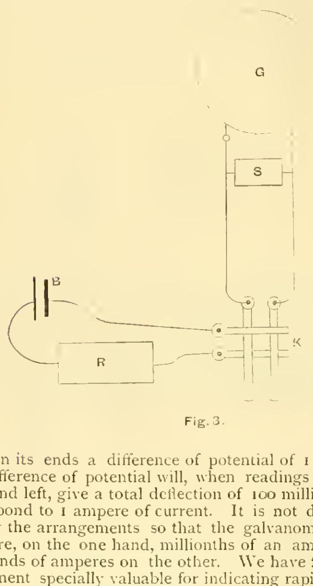


Fig. 3.

between its ends a difference of potential of 1 volt, and this difference of potential will, when readings are taken right and left, give a total deflection of 100 millimetres to correspond to 1 ampere of current. It is not difficult to modify the arrangements so that the galvanometer may measure, on the one hand, millionths of an ampere, and thousands of amperes on the other. We have found the instrument specially valuable for indicating rapid fluctuations of current in experiments on the induction of currents in armature coils when moved in a magnetic field. Its complete aperiodicity and the very small inertia, both mechanical and electrical, of its coil, render it most valuable for such work. The only defect—and that not a serious one—observed in three months of use, is a slight sub-permanent torsion on the suspending wires after taking a large deflection; but the method of taking double readings, first to right, then to left, eliminates any error that might arise from this cause.

THE BASALT-FIELDS OF NEW MEXICO

GEOLOGISTS interested in the history of the younger lava-floods, by which such vast areas both in the Old World and in the New have been deluged, will be glad to know that Capt. Dutton, of the United States Geological Survey, after a careful study of the modern volcanic phenomena of the Sandwich Islands, has undertaken the investigation of the basalt-territory lying in New Mexico, to the east and south of the area already so fully described by him in his Monographs on the Utah plateaux and the Cañon country. It was originally intended that he should have charge of the Survey of the Cascade Range. This arrangement was changed at the beginning of this last season. The Cascade ground was intrusted to his able assistant, Mr. Diller, while Capt. Dutton himself struck southward for a region in New Mexico, which he had long wished to study, from the light which he believed it would throw upon some of the later phases of volcanism in the Western Territories. I have received a long letter from him, written in his camp at the San Mateo Mountains, from which, with his permission, I send the following extract for publication in NATURE. ARCH. GEIKIE

Our wonderful Plateau Country we have known only in part, and the portion we have studied most is situated upon the western and northern side of the Colorado. Numerous geologists have hurried over the southern and south-eastern portion; but so rapidly have they been obliged to move in order to keep pace with the expeditions of which they were mere appendages that very little systematic knowledge could be gained. During the last two years our topographers have made some excellent maps of this region, and everything is ripe for the geologist.

I have described the western and southern portions of the Plateau Country as being very sharply defined in a geological as well as in a topographic sense. I think it will in great part prove to be equally well-defined in the south-eastern portions. Already it is clear to me that the Rio Grande River constitutes a portion of that boundary in this territory. Everywhere within range of my present field the strata characteristic of the Plateau Country rise gently from the Rio Grande to the westward. Cliffs, mesas, and terraces, carved buttes, and gorgeous colours are as typical of this region as they are of Utah and Northern Arizona. There is, however, more of the Cretaceous system preserved, and rocks of that age predominate, though the Trias and Permian are magnificently exposed. Indeed, the Vermilion Cliffs of Southern Utah have reappeared here in all their grandeur and glory, with but slight changes of detail.

But the features which are engaging my particular attention at this moment are the volcanic vestiges. This region has long been known under the mysterious name of *Malpais*—mysterious, however, only to those who have not read Humboldt's account of the *malpais* of Old Mexico. All the mesas, or platforms of sedimentary beds, within three or four miles of my camp, are sheeted over with basalt. The lava caps are not ordinarily more than fifty or a hundred feet thick; though just around me, in the very centre or focus of all, it becomes much thicker. In the valley-plains, also, are found many sheets of lava. But while the lavas upon the higher platforms and terraces are ancient, those in the valleys are very young. The centre of the activity has been (so far as concerns my present vicinity) the San Mateo Mountains. This name is synonymous with Mount Taylor, for the "Mountains" consist of a single volcanic pile (11,380 feet) carved into numerous spurs by magnificent gorges. It is a small Etna, built originally by outbreaks from its flanks as well as its summit. But the spread of the lavas from this centre is remarkable. To the north-north-east they reach out in unbroken continuity for forty-five miles, and for eighteen to thirty miles in the other directions. The lava beyond the immediate base of the mountain-cone is not thick. It forms a superficial sheet only on each mesa, or table, with a thickness varying from 50 to 200 feet.

The lava-capped strata have been cut into isolated mesas by subsequent erosion, and gaps of two or three miles sometimes separate one of these outliers from its parent mass.

This lava did not by any means come altogether from Mount Taylor itself, but from many vents scattered around its flanks, or situated miles away from it. These outlying vents are sufficiently preserved in many cases to admit of their complete identification, and they are very numerous. But one of the most charming and striking features consists in the numerous "necks" or "chimneys" which are left standing in the valley-plains beyond the farthest verge of the lava-capped mesas. Some of these are splendid objects. Newberry has depicted similar forms in the valley of the San Juan—a hundred miles or more to the north-west of here—in his admirable account of the observations made in his journey with Capt. Macomb's expedition. But these are even larger and finer, one being nearly two thousand feet high. What perfect testimony this is to the enormous erosion of the country! A child can read and comprehend it.

In the wide valley-plains which lie between the mesas are fresher fields of lava. Some look as if they could hardly be a century old; but my experience in the Hawaiian Islands has taught me that, in a dry country, a basalt-stream can preserve its freshness for many centuries. Still, it is clear enough that these eruptions occurred after hundreds, even thousands, of square miles of strata, overflowed by the older basalts, had been eroded away.

A striking fact in connection with these young basalts is the entire absence of all distinguishable traces of the vents from which they came. A few miles from here, in a broad valley, lies a basalt-field black as Erebus, and the whole circuit of it as accessible as a sheet of paper on a table, or a rug on the floor. There is no cone, no trace of fragmental ejecta, not a single feature in it to indicate the *locus* of eruption, except, however, the fact that the whole field, and the valley in which it lies, has a gentle declivity to the south-east, say forty feet per mile or so: and as the sheet follows the modern slope of the valley, it may be inferred that the vent is situated near the north-west end. There are many other fields of fresh lava, of which the above is sufficiently descriptive. One stream is nearly sixty miles long! Some of them, however, indicate unmistakably their sources in small depressed cones of very flat profiles. Great deluges of basalt have issued from them, flowing away for many miles, and spreading out five or six miles wide.

No fragmental ejecta (scoria, lapilli, &c.) have been found in connection with these young eruptions. But on Mount Taylor are numerous parasitic cinder-cones, of small or moderate dimensions, formed during the period of the eruption of the older basalts. The quantity of this fragmental material, however, is relatively very small.

The appearance of the young basalts is much like the rougher lava of Mauna Loa, called "aa" in the Hawaiian Islands. This is the typical *malpais* of this region. All the lava thus far seen is apparently basalt, though some of the older may prove to be andesitic when critically examined. There is little variety in it. It now appears that, all along the western, southern, and south-eastern rim of the Plateau Country is a marginal belt characterised by basaltic eruptions. I have identified two ages of eruption, both here and in South-West Utah. In the latter region I have associated these two periods of eruption with two periods of general upheaval of the plateaux. Whether the same will prove to be so here remains to be seen.

But it is getting dark, and I must close. We go to bed and get up with the chickens in this country.

C. E. DUTTON

NOTES

A MEETING of members of the University and others, to promote the objects of the Marine Biological Association, will be held at Cambridge on Saturday next, the 29th inst., in the Lecture-Room of Comparative Anatomy, the use of which for this purpose was granted to Prof. Newton by grace of the Senate on Thursday last. The Vice-Chancellor of the University (Dr. Ferrers, F.R.S., Master of Gonville and Caius College) has kindly undertaken to preside; and Prof. Moseley (the Chairman of the Council of the Association), Prof. Lankester (its Secretary), and Prof. Bell, of the British Museum and King's College, London, are expected to attend and set forth the aims and needs of their deserving body. The chair will be taken at three o'clock in the afternoon, and the proceedings (the details of which are being arranged by Mr. J. W. Clark, Superintendent of the Museum of Zoology and Comparative Anatomy, and Mr. Sedgwick, University Lecturer in Animal Morphology) are likely to be full of interest. The same evening the anniversary dinner of the Cambridge Philosophical Society will be given in the hall of Peterhouse, on the special invitation of the Master and Fellows of that ancient college, the newly-elected President of the Society, Prof. Foster, Sec. R.S., in the chair.

THE German Government has granted another sum of 7500*l.* for the scientific investigation of Central Africa, and 1900*l.* for the working out of the materials collected by German Polar expeditions.

THERE seems to be no end to the works of the highest value issued from the American *Nautical Almanac* Office. This week we have received a paper on "The Motion of Hyperion—a New Case in Celestial Mechanics," by Prof. Simon Newcomb, and another on "Lunar Inequalities due to the Ellipticity of the Earth," by Mr. G. W. Hill.

AT the first meeting of the new session of the Society of Arts held on November 19, Sir Frederick Abel made some feeling and pregnant remarks on the loss that not only the Society of Arts, but the whole scientific world, had sustained by the sudden and unexpected death of Sir William Siemens. In the course of his address Sir Frederick Abel said:—"It will be in the recollection of many whom I am addressing that, while Sir William Siemens was an ardent and successful labourer in the advancement of electric lighting, he also maintained the view that gas would continue to hold its own as the poor man's friend. The name of Siemens is associated with the origination of a great advance in the application of gas to the brilliant illumination of open spaces; but it must also be conceded that many streets and public places in London and the provinces bear evidence that even such simple modifications in the arrangement of old forms of gas-burners as have been introduced by Sugg and others have restored to gas some of its original prestige, and that, especially in towns where fogs are periodically prevalent, gas is now by no means wholly eclipsed by electricity as an open-air illuminant."

LAST week we announced the death of Dr. Wright of Cheltenham; to-day we have to make known that another of the lights of English geology has passed away. Mr. R. A. Godwin-Austen died at his residence, Shalford House, Guildford, on the morning of the 25th inst., after a long, but happily not a painful illness. He has for so many years lived retired in his country home that the younger generation of geologists has hardly known him personally. But his papers are classical in the literature of English geology, and long ago marked him out as one of the most philosophical of all the geological writers of this country.

MR. JAMES BUCKMAN, formerly one of the Professors at the Royal Agricultural College, Cirencester, and author of a number of geological papers, died at Bradford Abbas, Dorset, on the 23rd inst.

THE death is announced of Herr August Wilhelm Thienemann, the President of the German Society for the Protection of Birds, well-known in ornithological circles by his researches

and works. He died at Langenberg on the 5th inst., aged fifty-four years.

We regret to announce the death, at Paris, of M. Lartigue, aged fifty-four, a French electrician well known for his system of railway-signalling, which is largely in use on the French lines, and who had latterly held the post of General Director of the French Telephonic Company.

We regret to learn of the death, at the early age of thirty-four, of M. Henninger, one of the editors of *Science et Nature*. After a brilliant career as a medical student, he was appointed assistant to M. Wurtz in the chair of medical chemistry, as well as professor in l'École municipale de Chimie. He was the author of numerous articles in periodicals and encyclopædias, chiefly on chemistry.

The permanent Committee appointed by the International Ornithological Congress at Vienna for the purpose, among other tasks, of erecting ornithological stations of observation all over the globe, has addressed the Imperial Academy of Sciences in Vienna with the request that, so far as its sphere of action extends, it would seek out and appoint men, able and willing to undertake that office, to make regular observations, each within his own particular district, respecting the birds he finds there, their flight, incubation, mode of life, &c., and report them yearly (in the first quarter of the calendar year) to the Secretary of the Committee. The observations so collected will appear, each contribution being under the name and responsibility of the contributor, and will be scientifically digested and embodied by eminent experts. It is hoped that by these means many points hitherto dark in our knowledge of birds will be cleared up, and science generally be extended and enriched.

Admiral von Schleinitz has resigned the presidency of the Berlin Gesellschaft für Erdkunde, and has been replaced by Dr. W. Reiss. At the last meeting of this Society it was stated that there are now four Polar expeditions in preparation, of which one will start for the Antarctic regions. The African traveller, Dr. Aurel Schulz, has started on a journey across Africa from east to west, by way of the Zambesi River and the Victoria Falls. Lieut. Schulz, the leader of the German African expedition, reports from Cameroon that the joy of the German colonists there is most intense in consequence of recent political events.

The speeches delivered at the sittings of the Universal Prime Meridian Congress at Washington will be published *in extenso* in French, having been translated under the superintendence of M. Janssen, who was specially appointed by the Congress for that task.

The collections made by the Polar traveller, Capt. Jacobsen, by order of the Berlin Museum, on his American tour, are now on view at the Royal Ethnographical Museum at Berlin. That part of the collections which was obtained from Alaska territory, consists of some 4000 objects, collected among various Esquimaux tribes and among the Ingalik Indians living on the Yukon River. Most of the objects in question closely resemble those dating from the Stone Age, consisting principally of stone, bone, horn, shell, or wood.

The expedition of the German travellers, Dr. Clauss and Herr von den Steinen, who undertook to investigate the tributaries on the upper right bank of the Amazon and Xingu Rivers, starting from Paraguay and Cuyaba, have successfully accomplished this task, and safely arrived at Para at the end of October. The Brazilian Government, and especially Senhor Batovi, the Prefect of the province of Matto Grosso, have supported this scientific undertaking in a praiseworthy manner.

The Commission of the Centennial Exhibition for 1889 have already held several meetings with the object of determining upon a site for the Exhibition. As many as four places are competing for this honour, exclusive of the Bois de Boulogne, which was mentioned in connection with this matter some months ago.

The excellent "Monthly Reference-Lists," which are printed by Mr. W. E. Foster of the Providence Public Library, should be watched, says *Science*, by scientific men as well as by literary readers. The August number (vol. iv. No. 8) contains a handy index to articles on earthquakes—theories and observations—which was suggested by the shock of August 10, 1884. In judging of the list of memoirs and articles which are cited, the reader should remember that it is prepared for popular reading, and not as an index for the seismologist, nor even for the physicist. The second part of the same number is devoted to the early English explorations of America.

Telephonic service between Brussels and Antwerp was opened on October 20, the wires being used both for telegraphing and telephoning. The Belgian Government intends establishing telephonic connection between Brussels and Liége, Verviers, Mons, Ghent, Charleroi, and Louvain.

Among the awards given by the jurors at the National Italian Exhibition we notice a gold medal granted to Signor Ragona, Director of the Modena Observatory, for a complete set of astronomical, meteorological, and magnetical instruments designed by him and executed under his personal supervision.

In a recent number of the *Revue Scientifique* General Faidherbe draws the boundaries of the large section in the north-west of Africa in part already fallen, in part about to fall, under French control. In the beginning of April this year the French flag was floating from the fort of Bammakoo on the banks of the Niger, and on September 11 a French steamer had made a run down that river from Bammakoo to Koulikoro, bound for Timbuctoo, 300 miles lower down. Altogether, the French have at present the command of the Niger from Bourré to Boussa, some 700 leagues of water-course. From the North of Africa, again, a French railway runs from Arzen to Mécheria, and in a few years more will be continued to Imsalah. But Imsalah is already connected with Timbuctoo by the caravan routes which, under French protection, must become much more important. From Porto Novo on the Gulf of Guinea, moreover, the French cannot but push to Boussa on the Niger, and so complete their commercial route from the Mediterranean to the Gulf of Guinea.

We have received the Catalogue of the Natural History Collections of the Albany Museum, Grahamstown, Cape of Good Hope, and have much pleasure in observing how considerable the collection already is in specimens both native and foreign, especially birds. For the rest we can only join heartily in the hope expressed by the zealous curator in the preface, that the present inventory of natural history treasures in the young colony will stimulate able friends, at once of the colony and of natural science, to add to the stock and so promote the benign study of Nature in a part of the world not without its share of political troubles. We expect that the promised list of botanical specimens in the herbarium will do justice to the botany, at least, of the South of Africa.

On the eastern coast of Schleswig the experiments to establish oyster-beds are being actively pursued, under the direction of Prof. Möbius, who is an authority on the subject. Quantities of young American and Canadian oysters have been brought over, and are being "sown out" during favourable weather. The experiments made last year have, so far, not been attended with satisfactory results.

The organisation of the Pneumatic Postal Service will be completed on December 15 next for the whole of Paris. This great work, costing more than a million francs and involving over 60,000 metres' length of pipes, was inaugurated by M. de

Couchy, who, seventeen years ago, under the Empire, was Director of the French Telegraphs. The charge for carrying a letter to any place within the fortifications has been fixed at 3 *l*. The two extreme points in the service are about 11,000 metres apart, and the time required for the delivery of a letter to the remotest place in the most unfavourable circumstances, and including its conveyance from the nearest station, will be within one hour.

THE Scientific Exhibition at Paris, always held on the occasion of the grand *soirée* given by Admiral Mouchez, Director of the Paris Observatory, will this year be under the management of the French Electrical Society, and its exhibits will therefore be confined to objects relating to that branch of science.

PROF. MELL, Director of the Alabama Weather Service, announces, in *Science*, that through the liberality of the Chief Signal Officer, and of several railways, daily weather-signals, predicting changes of weather and temperature, will be displayed at over one hundred telegraph-stations in that State. The predictions will be received by the Director at an early hour every morning from the Signal Office in Washington, and then promptly distributed along the railways. By paying for the cost of the signal-flags (about six dollars), any town or telegraph-station will receive free telegraphic warning of the daily weather changes. Only about five minutes are required to set the flags. A similar system has been for some time in operation in Ohio and in part of Pennsylvania, and it will doubtless have further extension.

THE Commander-in-Chief of the French army in Tonquin has given orders to have a meteorological observatory erected in Haiphong, the chief port in the delta of the Red River, to serve as a basis for a network of meteorological stations with which it is intended to cover eventually the whole of Annam and Tonquin, and which will be in telegraphic communication with the observatory in Hong Kong.

THE series of illustrations of the methods and stages of instruction in handicraft and technical training contributed by the Austrian Government to the Health Exhibition is stated to have been purchased by the Japanese Government from the Technological Museum at Vienna. The Japanese authorities have also made numerous exchanges with the representatives of other countries exhibiting at South Kensington.

THE additions to the Zoological Society's Gardens during the past week include a Common Seal (*Phoca vitulina*) from British Seas, presented by Mr. James Wyat; two Barred Doves (*Geopelia striata*), three Eastern Turtle Doves (*Turtur meena*) from Java, presented by Mr. Emil Berg; a Green Monkey (*Cercopithecus callitrichus* ♂) from West Africa, deposited; a Red-throated Amazon (*Chrysotis collaria*) from Jamaica, a Red-tailed Amazon (*Chrysotis erythrura*) from Brazil, three Blue Snow Geese (*Chen cærulescens*) from Alaska, purchased; a Bernier's Ibis (*Ibis bernieri*) from Madagascar, received in exchange.

OUR ASTRONOMICAL COLUMN

THE ECLIPSE OF THUCYDIDES, B.C. 431, AUGUST 3.—There has been much discussion from time to time with reference to the solar eclipse recorded by Thucydides in the first year of the Peloponnesian war, and long identified as that which occurred on August 3, B.C. 431. We are told, "the sun was eclipsed after midday, and having assumed a crescent form, some of the stars having also appeared, it again became full-orbed." This eclipse was not total, as has been frequently stated, but narrowly annular. Dr. Hartwig in 1859 calculated the circumstances according to the solar and lunar tables of Hansen, and his results were published, with those applying to other eclipses mentioned by Thucydides, in No. 1203 of *Astronomische Nachrichten*. The greatest phase, by his calculations, falls at 5h. 9m. mean time at Athens, and the magnitude of the eclipse is 0·75, rather small, it will be considered, for stars to have been brought into view. But, when all the conditions of the case are borne in mind, it would appear quite possible, to speak within bounds, that Hansen's longitude of the moon may require at that epoch a correction which would suffice, with the rapid descent of the central line in latitude, to cause a great eclipse at Athens, leaving the sun of crescent form, as Thucydides reports, but with the crescent very narrow. In such a climate bright planets and stars might well have been discerned. Venus was westward at an altitude of some 35°, Mars would be near the western horizon, Jupiter had set, while Saturn was near the meridian at an altitude of something like 45°. Of the stars, Spica, Arcturus, Antares, and Vega were in favourable positions for observation.

Sir George Airy informed the writer of these lines some years since that, on the occasion of the partial eclipse of September 7, 1820, he "saw one or two stars" at Cambridge. On calculating the circumstances of the eclipse for that place, it appears the magnitude was 0·88. This is an interesting case in point.

WOLF'S COMET.—A few week's since it was remarked in this column that, according to the first elliptical orbit calculated by Prof. Krueger, this comet would approach very near to the orbit of Jupiter in about 209° heliocentric longitude, and great perturbation was possible early in the year 1875, so that the comet might not have been moving long in its present track. On this subject Prof. Krueger, who has recalculated the elements of the comet's orbit from a much wider extent of observation, expresses himself as follows in No. 2629 of the *Astronomische Nachrichten*:—"In Nr. 782 der NATURE (1884, October 23) ist hierauf bereits aufmerksam gemacht worden; ich hielt indessen damals die ersten Elemente für viel ungenauer, als sie wirklich waren, und glaubte, dass Erörterungen dieser Art noch etwas aufzuschieben seien. Die nachfolgende Rechnung bestätigt indessen die in der NATURE ausgesprochene Vermuthung in überraschender Weise." In fact, Prof. Krueger finds by his new orbit that on May 28, 1875, the comet's distance from Jupiter was less than 0·1 of the earth's mean distance from the sun, and hence it is probable that before the spring of this year the comet may have been describing a very different orbit to that in which it now moves. This, as was before remarked, will form an interesting subject of investigation, when definitive elements have been deduced from a combination of all the observations of the present appearance.

In Prof. Krueger's last orbit, founded on observations to November 7, the period of revolution is 2466·06 days, according to which the comet would have been in perihelion about February 16, 1878, in R.A. 23h. 58m., Decl. + 2°, distant from the earth 2·32, and under such circumstances not likely to have been seen. We subjoin other elements of the orbit:—

Semi-axis major ...	3·5722	Perihelion distance ...	1·5719
,, minor ...	2·9596	Aphelion ,, ..	5·5725
Semi-parameter ...	2·4521	Excentricity	0·559966

MINIMA OF ALGOL.—The following are approximate geocentric Greenwich times of minima of Algol, calculated from elements upon which the later observations of Schmidt have been brought to bear:—

	h. m.		h. m.		h. m.
Nov. 27 ...	13 24	Dec. 23 ...	8 45	Jan. 26 ..	18 35
30 ...	10 13	26 ...	5 34	29 ...	15 24
Dec. 3 ...	7 2	Jan. 6 ...	16 51	Feb. 1 ...	12 14
14 ...	18 18	9 ...	13 40	4 ...	9 3
17 ...	15 7	12 ...	10 29	7 ..	5 52
20 ...	11 56	15 ...	10 18		

THE WAVE THEORY OF LIGHT[1]

THE subject upon which I am to speak to you this evening is happily for me not new in Philadelphia. The beautiful lectures on light which were given several years ago by President Morton, of the Stevens' Institute, and the succession of lectures on the same subject so admirably illustrated by Prof. Tyndall, which many now present have heard, have fully prepared you for anything I can tell you this evening in respect to the wave theory of light.

It is indeed my humble part to bring before you some mathematical and dynamical details of this great theory. I cannot have the pleasure of illustrating them to you by anything compar-

[1] A Lecture delivered at the Academy of Music, Philadelphia, under the auspices of the Franklin Institute, September 29, 1884, by Sir William Thomson, F.R.S., LL.D.

able with the splendid and instructive experiments which many of you have already seen. It is satisfactory to me to know that so many of you, now present, are so thoroughly prepared to understand anything I can say, that those who have seen the experiments will not feel their absence at this time. At the same time I wish to make them intelligible to those who have not had the advantages to be gained by a systematic course of lectures. I must say in the first place, without further preface, as time is short and the subject is long, simply that sound and light are both due to vibrations propagated in the manner of waves; and I shall endeavour in the first place to define the manner of propagation and mode of motion that constitute those two subjects of our senses, the sense of sound and the sense of light.

Each is due to vibrations. The vibrations of light differ widely from the vibrations of sound. Something that I can tell you more easily than anything in the way of dynamics or mathematics respecting the two classes of vibrations is, that there is a great difference in the frequency of the vibrations of light when compared with the frequency of the vibrations of sound. The term "frequency" applied to vibrations is a convenient term, applied by Lord Rayleigh in his book on sound to a definite number of full vibrations of a vibrating body per unit of time. Consider, then, in respect to sound, the frequency of the vibrations of notes, which you all know in music represented by letters, and by the syllables for singing, the do, re, mi, etc. The notes of the modern scale correspond to different frequencies of vibrations. A certain note and the octave above it correspond to a certain number of vibrations per second and double that number.

I may explain in the first place conveniently the note called "C"; I mean the middle "C"; I believe it is the C of the tenor voice, that most nearly approaches the tones used in speaking. That note corresponds to two hundred and fifty-six full vibrations per second, two hundred and fifty-six times to and fro per second of time.

Think of one vibration per second of time. The seconds pendulum of the clock performs one vibration in two seconds, or a half vibration in one direction per second. Take a ten-inch pendulum of a drawing-room clock, which vibrates twice as fast as the pendulum of an ordinary eight-day clock, and it gives a vibration of one per second, a full period of one per second to and fro. Now think of three vibrations per second. I can move my hand three times per second easily, and by a violent effort I can move it to and fro five times per second. With four times as great force, if I could apply it, I could move it twice five times per second.

Let us think, then, of an exceedingly muscular arm that would cause it to vibrate ten times per second, that is ten times to the left and ten times to the right. Think of twice ten times, that is, twenty times per second, which would require four times as much force; three times ten, or thirty times a second, would require nine times as much force. If a person were nine times as strong as the most muscular arm can be, he could vibrate his hand to and fro thirty times per second, and without any other musical instrument could make a musical note by the movement of his hand which would correspond to one of the pedal notes of an organ.

If you want to know the length of a pedal pipe, you can calculate it in this way. There are some numbers you must remember, and one of them is this. You, in this country, are subjected to the British insularity in weights and measures; you use the foot and inch and yard. I am obliged to use that system, but I apologise to you for doing so, because it is so inconvenient, and I hope all Americans will do everything in their power to introduce the French metrical system. I hope the evil action performed by an English Minister, whose name I need not mention, because I do not wish to throw obloquy on any one, may be remedied. He abrogated a useful rule, which for a short time was followed, and which I hope will soon be again enjoined, that the French metrical system be taught in all our national schools. I do not know how it is in America. The school system seems to be very admirable, and I hope the teaching of the metrical system will not be let slip in the American schools any more than the use of the globes.

I say this seriously. I do not think any one knows how seriously I speak of it. I look upon our English system as a wickedly brain-destroying piece of bondage under which we suffer. The reason why we continue to use it is the imaginary difficulty of making a change, and nothing else; but I do not think in America that any such difficulty should stand in the way of adopting so splendidly useful a reform.

I know the velocity of sound in feet per second. If I remember rightly, it is 1089 feet per second in dry air at the freezing-point, and 1115 feet per second in air of what we call moderate temperature, 59° or 60°—(I do not know whether that temperature is ever attained in Philadelphia or not; I have had no experience of it, but people tell me it is sometimes 59° or 60° in Philadelphia, and I believe them)—in round numbers let us call it 1000 feet per second. Sometimes we call it a thousand musical feet per second, it saves trouble in calculating the length of organ pipes; the time of vibration in an organ pipe is the time it takes a vibration to run from one end to the other and back. In an organ pipe 500 feet long the period would be one per second; in an organ pipe ten feet long, the period would be fifty per second; in an organ pipe twenty feet long, the period would be twenty-five per second at the same rate. Thus twenty-five per second, and fifty per second of frequencies, corresponds to the periods of organ pipes of twenty feet and ten feet.

The period of vibration of an organ pipe, open at both ends, is approximately the time it takes sound to travel from one end to the other and back. You remember that the velocity in dry air in a pipe ten feet long is a little more than fifty periods per second; going up to 256 periods per second, the vibrations correspond to those of a pipe two feet long. Let us take 512 periods per second; that corresponds to a pipe about a foot long. In a flute, open at both ends, the holes are so arranged that the length of the sound-wave is about one foot, for one of the chief "open notes." Higher musical notes correspond to greater and greater frequency of vibration, viz., 1000, 2000, 4000 vibrations per second; 4000 vibrations per second correspond to a piccolo flute of exceedingly small length; it would be but one and a half inches long. Think of a note from a little dog-call, or other whistle, one and a half inches long, open at both ends, or from a little key having a tube three-quarters of an inch long, closed at one end; you will then have 4000 vibrations per second.

A wave length of sound is the distance traversed in the period of vibration. I will illustrate what the vibrations of sound are by this condensation travelling along our picture on the screen. Alternate condensations and rarefactions of the air are made continuously by a sounding body. When I pass my hand vigorously in one direction, the air before it becomes dense, and the air on the other side becomes rarefied. When I move it in the other direction, these things become reversed; there is a spreading out of condensation from the place where my hand moves in one direction and then in the reverse. Each condensation is succeeded by a rarefaction. Rarefaction succeeds condensation at an interval of one-half what we call "wave lengths." Condensation succeeds condensation at the full interval of what we call wave lengths.

We have here these luminous particles on this scale,[1] representing portions of the air close together, dense; a little higher up, portions of air less dense. I now slowly turn the handle of the apparatus in the lantern, and you will see the luminous sectors showing condensation travelling slowly upwards on the screen; now you have another condensation; making one wave length.

This picture or chart represents a wave length of four feet. It represents a wave of sound four feet long. The fourth part of a thousand is 250. What we see now of the actual scale represents the lower note C of the tenor voice. The air from the mouth of a singer is alternately condensed and rarefied just as you see here.

But that process shoots forward at the rate of one thousand feet per second; the exact period of the motion is 256 vibrations per second for the actual case before you. Follow one particle of the air forming part of a sound wave, as represented by these moving spots of light on the screen; now it goes down, then another portion goes down rapidly; now it stops going down; now it begins to go up; now it goes down and up again.

As the maximum of condensation is approached, it is going up with diminishing maximum velocity. The maximum of rarefaction has now reached it, and the particle stops going up and begins to move down. When it is of mean density the particles are moving with maximum velocity, one way or the other. You can easily follow these motions, and you will see that each particle moves to and fro, and the thing that we call *condensation* travels along.

[1] Alluding to a moving diagram of wave motion of sound produced by a working slide for lantern projection.

I shall show the distinction between these vibrations and the vibrations of light. Here is the fixed appearance of the particles when displaced but not in motion. You can imagine particles of something, the thing whose motion constitutes light. This thing we call the luminiferous ether. That is the only substance we are confident of in dynamics. One thing we are sure of, and that is the reality and substantiality of the luminiferous ether. This instrument is merely a method of giving motion to a diagram designed for the purpose of illustrating wave motion of light. I will show you the same thing in a fixed diagram, but this arrangement shows the mode of motion.

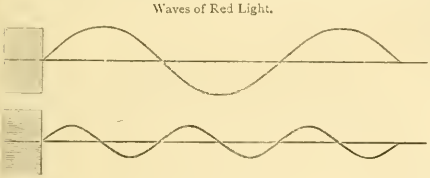
Now follow the motion of each particle. This represents a particle of the luminiferous ether, moving at the greatest speed when it is at the middle position.

You see the two modes of vibration,[1] sound and light now moving together,—the travelling of the wave of condensation and rarefaction, and the travelling of the wave of transverse displacement. Note the direction of propagation. Here it is from your left to your right, as you look at it. Look at the motion when made faster. We have now the direction reversed. The propagation of the wave is from right to left, again the propagation of the wave is from left to right; each particle moves perpendicularly to the line of propagation.

I have given you an illustration of the vibration of sound waves, but I must tell you that the movement illustrating the condensation and rarefaction represented in that moving diagram are necessarily very much exaggerated, to let the motion be perceptible, whereas the greatest condensation in actual sound motion is not more than one or two per cent. or a small fraction of a per cent. Except that the amount of condensation was exaggerated in the diagram for sound, you have a correct representation of what actually takes place in the low note C.

On the other hand, in the moving diagram representing light waves what had we? We had a great exaggeration of the inclination of the line of particles. You must first imagine a line of particles in a straight line, and then you must imagine them disturbed in a wave curve, the shape of the curve corresponding to the disturbance. Having seen what the propagation of the wave is, look at this diagram and then look at that one. This, in light, corresponds to the different sounds I spoke of at first. The wave length of light is the distance from crest to crest of the wave, or from hollow to hollow. I speak of crests and hollows, because we have a diagram of ups and downs as the diagram is placed.

Waves of Red Light.



Waves of Violet Light.

Here, then, you have a wave length.[2] In this lower diagram you have the wave length of violet light. It is but one-half the length of the upper wave of red light; the period of vibration is but half as long. Now, on an enormous scale, exaggerated not only as to slope, but immensely magnified as to wave length, we have an illustration of the waves of light. The drawing marked "red" corresponds to red light, and this lower diagram corresponds to violet light. The upper curve really corresponds to something a little below the red ray of light in the spectrum, and the lower curve to something beyond the violet light. The variation in length between the most extreme rays is in the proportion of four and a half of red to eight of the violet, instead of four and eight; the red waves are nearly as one to two of the violet.

To make a comparison between the number of vibrations for each wave of sound and the number of vibrations constituting light waves, I may say that 30 vibrations per second is about the smallest number which will produce a musical sound; 50 per second gives one of the grave pedal notes of an organ, 100 or 200 per second give the low notes of the bass voice, higher notes with 250 per second, 300 per second, 1000, 4000, up to 8000 per second give about the shrillest notes audible to the human ear.

Instead of the numbers, which we have, say in the most commonly used part of the musical scale, *i.e.* from 200 or 300 to 600 or 700 per second, we have millions and millions of vibrations per second in light waves; that is to say, 400 million million per second, instead of 400 per second. That number of vibrations is performed when we have red light produced.

An exhibition of red light travelling through space from the remotest star is due to the propagation by waves or vibrations, in which each individual particle of the transmitting medium vibrates to and fro 400 million million times in a second.

Some people say they cannot understand a million million. Those people cannot understand that twice two makes four. That is the way I put it to people who talk to me about the incomprehensibility of such large numbers. I say *finitude* is incomprehensible, the infinite in the universe *is* comprehensible. Now apply a little logic to this. Is the negation of infinitude incomprehensible? What would you think of a universe in which you could travel one, ten, or a thousand miles, or even to California, and then find it come to an end? Can you suppose an end of matter, or an end of space? The idea is incomprehensible. Even if you were to go millions and millions of miles the idea of coming to an end is incomprehensible.

You can understand one thousand per second as easily as you can understand one per second. You can go from one to ten, and ten times ten, and then to a thousand without taxing your understanding, and then you can go on to a thousand million and a million million. You can all understand it.

Now 400 million million vibrations per second is the kind of thing that exists as a factor in the illumination by red light. Violet light, after what we have seen and have illustrated by that curve, I need not tell you corresponds to vibrations of 800 million million per second. There are recognisable qualities of light caused by vibrations of much greater frequency and much less frequency than this. You may imagine vibrations having about twice the frequency of violet light and one-fifteenth the frequency of red light and still you do not pass the limit of the range of continuous phenomena only a part of which constitutes *visible* light.

Everybody knows the "photographer's light" and has heard of *invisible* light producing visible effects upon the chemically prepared plate in the camera. Speaking in round numbers, I may say that, in going up to about twice the frequency I have mentioned for violet light, you have gone to the extreme end of the range of known light of the highest rates of vibration; I mean to say that you have reached the greatest frequency that has yet been observed.

When you go below visible red light what have you? We have something we do not see with the eye, something that the ordinary photographer does not bring out on his photographically sensitive plates. It is light, but we do not see it. It is something so closely continuous with light visible, that we may define it by the name of invisible light. It is commonly called radiant heat; invisible radiant heat. Perhaps, in this thorny path of logic, with hard words flying in our faces, the least troublesome way of speaking of it is to call it radiant heat. The heat effect you experience when you go near a bright, hot coal fire, or a hot steam boiler; or when you go near, but not over, a set of hot-water pipes used for heating a house; the thing we perceive in our face and hands when we go near a boiling pot and hold the hand on a level with it, is radiant heat; the heat of the hands and face caused by a hot fire, or a hot kettle when held under the kettle, is also radiant heat.

You might readily make the experiment with an earthen teapot; it radiates heat better than polished silver. Hold your hands below, and you perceive a sense of heat; above the teapot you get more heat; either way you perceive heat. If held over the teapot you readily understand that there is a little current of air rising. If you put your hand under the teapot you get cold air; the upper side of your hand is heated by radiation, while the lower side is fanned and is actually cooled by virtue of the heated kettle above it.

That perception by the sense of heat, is the perception of something actually continuous with light. We have knowledge of rays of radiant heat perceptible down to (in round numbers) about four times the wave length, or one-fourth the period of visible, or red light. Let us take red light at 400 million

[1] Showing two moving diagrams, simultaneously, on the screen, one depicting a wave motion of light, the other a sound vibration.

[2] Exhibiting a large drawing, or chart, representing a red and a violet wave of light.

million vibrations per second; then the lowest radiant heat, as yet investigated, is about 100 million million per second in the way of frequency of vibration.

I had hoped to be able to give you a lower figure. Prof. Langley has made splendid experiments on the top of Mount Whitney, at the height of 15,000 feet above the sea-level, with his "bolometer," and has made actual measurements of the wave lengths of radiant heat down to exceedingly low figures. I will read you one of the figures; I have not got it by heart yet, because I am expecting more from him.[1] I learned a year and a half ago that the lowest radiant heat observed by the diffraction method of Prof. Langley corresponded to 28/100,000ths of a centimetre for wave length, twenty-eight as compared with red light, which is 7·3; or nearly fourfold. Thus wave lengths of four times the amplitude, or one-fourth the frequency per second of red light have been experimented on by Prof. Langley, and recognised as radiant heat.

Photographic, or actinic light, as far as our knowledge extends at present, takes us to a little less than one-half the wave length of violet light. You will thus see that while our acquaintance with wave motion below the red extends down to one-quarter of the slowest rate which affects the eye, our knowledge of vibrations at the other end of the scale only comprehends those having twice the frequency of violet light. In round numbers we have four octaves of light, corresponding to four octaves of sound in music. In music the octave has a range to a note of double frequency. In light we have one octave of visible light, one octave above the visible range, and two octaves below the visible range. We have 100 per second, 200 per second, 400 per second (million million understood) for invisible radiant heat, 800 per second for visible light, and 1600 per second for invisible light.

One thing in common to the whole is the heat effect. It is extremely small in moonlight, so small that nobody until recently knew there was any heat in the moon's rays. Herschel thought it was perceptible in our atmosphere by noticing that it dissolved away very light clouds, an effect which seemed to show in full moonlight more than when we have less than full moon. Herschel, however, pointed this out as doubtful; but now, instead of its being a doubtful question, we have Prof. Langley giving as a fact that the light from the moon drives the indicator of his sensitive instrument clear across the scale, and with a comparatively prodigious heating effect!

I must tell you that if any of you want to experiment with the heat of moonlight you must compare the heat with whatever comes within the influence of the moon's rays only. This is a very necessary precaution; if, for instance, you should take your bolometer or other heat detector from a comparatively warm room into the night air, you would obtain an indication of a fall in temperature owing to this change. You must be sure that your apparatus is in thermal equilibrium with the surrounding air, then take your burning-glass, and first point it to the moon, and then to space in the sky beside the moon; you thus get a differential measurement, in which you compare the radiation of the moon with the radiation of the sky. You will then see that the moon has a distinctly heating effect.

(*To be continued.*)

[1] Since my lecture I have heard from Prof. Langley that he has measured the refrangibility by a rock-salt prism, and inferred the wave length of heat rays from a "Leslie cube" (a metal vessel of hot water radiating from a blackened side). The greatest wave length he has thus found is one-thousandth of a centimetre, which is seventeen times that of sodium light. The corresponding period is about thirty million million to the second.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Professorship of Political Economy will be filled up on Dec. 13. The Higher Local Examinations were held last June at 21 centres, and attended by 960 candidates (chiefly women), a decrease of 27. In Arithmetic the work of most of the candidates was by no means good. Euclid's propositions were well and neatly written out. In some cases attempts were made to improve upon Euclid, but usually with disastrous results. The book-work of Geometrical Conics was fairly done by the few who attempted it, but only one rider out of four was solved by any candidate. Only a few candidates tried Analytical Geometry, and they nearly all did badly. Some very intelligent work was sent up in Algebra and Trigonometry. In Statics and Dynamics the majority of candidates had made but little way. The attempts at Astronomy were few and generally slight. Altogether, in Group C (Mathematics), there were only 140 candidates, of whom 41 failed, 70 obtained a third class, and only 12 attained a first class.

In Political Economy many of the answers were vague and indefinite. In Logic the simpler questions were well answered, and Mill's inductive methods were understood. Of 45 candidates, however, only 2 gained a first class.

In Group E (Natural Science), out of 62 candidates 25 failed, while 5 obtained a first class. In Elementary Chemistry and Physics the answers were mostly unsatisfactory; Elementary Biology was much better done. Very few candidates seemed to connect the definitions of Chemistry with the facts.

In Physiology and Zoology marked improvement was shown in the answers. The principal fault was still the want of personal acquaintance with phenomena that might be easily observed. In Botany the descriptions of plants were fairly well done, and the questions on Vegetable Physiology were attempted with some success by several candidates. No candidate, however, gave a good description of the germination of a seed.

In Physical Geography and Geology the answers were, on the whole, very good, and remarkably free from errors. The one common failing was the absence of good diagrams.

Mr. James Sully, M.A. Lond., has been appointed a member of the Board of Electors to the Professorship of Mental Philosophy and Logic, in place of the late Dr. Todhunter.

Dr. Donald MacAlister has been appointed by the Senate to be an Examiner in Medicine.

MANCHESTER.—At a meeting of the Council of the Victoria University, Owens College, on Friday, November 21, Mr. J. H. Fowler, B.A. (Oxon.) was elected, on the recommendation of the Senate, to a Berkeley Research Fellowship in Zoology. The Platt Physiological Scholarship, which is also for the encouragement of original research, has been awarded to Mr. C. F. Marshall, B.Sc. (Vict.).

SCIENTIFIC SERIALS

Journal of the Anthropological Institute of Great Britain and Ireland, November 1884.—The ethnology of Egyptian Soudan, a timely and important paper, by Prof. A. H. Keane.—Additional observations on the osteology of the natives of the Andaman Islands, by Prof. Flower.—The Kubus, a small tribe in Central Sumatra, by Mr. Forbes.—Notes on prehistoric remains in Antiparos, by Mr. Theodore Bent.—The Deme and the Horde, by Messrs. Howitt and Fison; an attempt to show a resemblance between the general organisation and usages of the Attic tribes and those of the Australian aborigines.—African symbolic messages, by the Rev. C. Gollmer, describing the method in which natives of the Yoruba country send messages to absent friends by means of shells, feathers, corn, stone, coal, sticks, &c.—On the size of teeth as a character of race, by Prof. Flower.—A Hindu prophetess, by Mr. Walhouse.—On certain less familiar forms of Palæolithic flint implements from the gravel at Reading, by Mr. Shrubsole.

THE *American Journal of Science* for November contains:—Mr. Asa Gray's paper on the characteristics of the North American flora, read before the Biological Section of the British Association at the Montreal meeting; also columbite in the Black Hills of Dakota, by Mr. Blake; spectro-photometric study of pigments, by Mr. Nichols; criticism of Becker's theory of faulting, by Mr. Ross Bourne; the difference between sea and continental climate with regard to vegetation, by Mr. Buysman; chemical affinity, by Mr. J. W. Langley; the relation between the electromotive force of a Daniell cell and the strength of the zinc sulphate solution, by Mr. Carhart; a notice of the remarkable marine fauna occupying the outer banks of the southern coast of New England, by Mr. Verrill; and a note by Mr. J. D. Dana, on the Costlandt and Stray Point hornblendic and augitic rocks.

Rivista Scientifico-Industriale, October 30.—On the origin of atmospheric electricity, of thunder-storms and volcanic eruptions (continued), by Prof. Giovanni Luvini.—Note on a simple method for determining the velocity of a railway train, by Prof. Steiner.—Note on Bauer's new radiometer, by the Editor.—On the vitality of insects in oxygen, hydrogen, carbonic acid, and prussic acid, by the Editor.

SOCIETIES AND ACADEMIES

London

Anthropological Institute, November 11.—Prof. Flower, F.R.S., President, in the chair.—The election of Horatio Hale, D. H. Talbot, Dr. F. A. Colby, and Mrs. E. A. Smith was announced.—Mr. Francis Galton described the object, method, and appliances of the late Anthropometric Laboratory at the International Health Exhibition, reserving the statistical results, which were not yet fully worked out, for another occasion. He established it to show with how little expense an elaborate course of measurements might be made, and how popular such a system of measurements would be. The result was that 9344 persons passed through the laboratory, each of them being measured in seventeen distinct particulars for the sum of 3*d.*, in a compartment only 6 feet wide and 36 feet long. The popularity of the laboratory was so great that its door was besieged by far more applicants than could be admitted, and many persons made repeated attempts and waited long for their turn, but at last gave up their attempts as hopeless. So many applications have been made abroad and at home for duplicates of the instrumental outfit that it was advisable that any suggested improvements in them should be considered before they became established in use. The present paper was to invite discussion. An identical set of instruments to those used at the Exhibition have been set up by Mr. Gammage, optical instrument maker, at 172, Brompton Road, assisted by Mr. Williams, who, between them, conducted all the measurements at the Healtheries; they make a moderate charge for measuring and keeping a register of the results.—Mr. H. O. Forbes read a paper on the people of the island of Buru.

Edinburgh

Royal Physical Society, November 19.—Ramsay H. Traquair, M.D., F.R.SS.L. and E., President, in the chair.—The President delivered the opening address, in which, after referring to the loss which the Society had sustained in the death of Dr. J. A. Smith, for many years its secretary, and subsequently one of its presidents, he called attention to the proceedings of last session as showing that the prosperity of the Society appeared not only in the increase of membership and ingathering of fees, but in scientific work accomplished.—Dr. Traquair then proceeded to discuss the subject of "Biological Nomenclature." Having shown the necessity for a nomenclature intelligible to all scientific men as distinguished from the common names of plants and animals, which varied in different countries, he referred to the introduction by Linnæus of the binomial system, under which each form received a generic and a specific name, and to the action taken by the British Association in 1842, and again in 1865, with the view of securing uniformity. Their rules and recommendations had, he said, worked well for the benefit of science, but they had not been in every particular followed by naturalists abroad, while even in this country there were often heard ominous notes of dissent as to their sufficiency for the wants of the science of the present day. They must, however, form the basis for all subsequent attempts to rectify the subject. Proceeding to discuss those rules, he urged the necessity of strict adherence to priority, and said he agreed with the rule that publication should mean the insertion of the description in a printed book, with the addition that such book might be had on sale. He also expressed concurrence in the recommendation which deprecated the propounding of harsh names, but he could hardly agree with the denunciation of what were called nonsense names, that was, names coined at random without any derivation whatever. The difficulty of devising generic names, not preoccupied, was immense: and if a person with a musical ear invented a nicely sounding word of classical form, surely it was as good as some cacophonous "jaw-breaker," whatever its derivation. Touching next on the comparative value of binomirl, trinomial, and quadrinomial systhms, he hardly thought the time had come for any radical interference with the binomial, which, notwithstanding all its defects, had worked so well from the time of Linnæus to our own. While condemning the practice adopted by some writers of coining new English names, he was in favour of appending the common names, where such really existed, to the scientific ones for behoof of the unscientific.—On the motion of Prof. Duns, a vote of thanks was accorded to the retiring President for his address and for his services in the chair.

Manchester

Literary and Philosophical Society, October 7.—A paper was communicated by Alfred Brothers, F.R.A.S., on the pink sun-glow which he had noticed at midday as early as January this year, and again on July 5 and at the end of August. On the evening of October 3 he observed the same phenomenon by clear moonlight, and attributed it, therefore, to our atmosphere, and not to its being a real appendage of the sun, as had been given out.

October 21.—Joseph Baxendell, F.R.S., communicated a note on the visibility of the moon during total lunar eclipses, in which it was sought to show that the visibility in question might in no inconsiderable measure be due to the outer corona, which extended to a much greater distance on each side of the sun than the semi-diameter of the earth as seen from the moon.—Prof. H. E. Roscoe, F.R.S., contributed a paper on the diamond-bearing rocks of South Africa. Two shafts sunk in the Kimberley Mine—one in the "pipe," the other in the shale near it—passed through the following strata:—

(1) "*Pipe*"		(2) "*Outside the Pipe*"	
Red Sand	3 feet	Red Sand	3 feet
Tufaceous Limestone	15 ,,	Tufaceous Limestone...	5 ,,
Soft yellow earthy diamond rock	30 ,,	Yellow Shale	20 ,,
Soft blue diamond rock proved to	282 ,,	Black carbonaceous do.	10 ,,
		Two thin bands of black dust in Shale... ...	1 foot
		Black Shale	236 feet
Total excavated ...	330 feet	Dolerite	2 ,,
		Total excavated ...	277 feet

The diamonds were found in the yellow and blue "Stuff" along with garnets, mica, bronzite, ilmenite, pyrite, &c., and were separated by washing the broken-up earth in sluices similar to those used in gold-mining. The annual value of the diamonds from Kimberley was said to be 3,750,000*l.*, and the total amount raised since 1870, to reach the enormous sum of 40,000,000*l.* Five different specimens of the strata were then produced and their analyses given.—Notes on envelopes and singular solutions (continued), by Sir James Cockle, F.R.S.

Paris

Academy of Sciences, November 17.—M. Rolland, President, in the chair.—On the breathing-bags of the *Calao rhinoceros*, by M. Alph. Milne-Edwards. The specimen of the species of hornbill forming the subject of the paper was brought to Paris last summer by M. P. Fauque, head of the scientific mission recently sent to Sumatra by the Minister of Public Instruction. Owing to the peculiar disposition of its breathing apparatus the *Calao rhinoceros* is a remarkably light bird, its weight scarcely exceeding 1500 grms., although it is about the size of a turkey.—On the anæsthetic action of the chlorhydrate of cocaine, by M. Vulpian. So powerful is this anæsthetic, which is at present the subject of numerous experiments by M. Koller and other physiologists, that an aqueous solution of one part salt of cocaïne and ninety-nine parts of water inserted under the eyelids produces complete insensibility of the conjunctiva and cornea in the human eye. But the effect, obtained in three or four minutes, lasts only a few minutes. Experiments made on the dog, frog, and other animals, have been attended with like results.—Contribution to the study of the deposits of phosphates (lime, iron, &c.), in the Departments of the Drôme, Isère, and other parts of South-East France, by M. P. de Gasparin.—Experimental demonstration of the inversion of the electromotor force produced by the contact of iron and copper at a high temperature, by M. F. F. Le Roux. From the results of several series of experiments, conducted under varying conditions, the author concludes that at about the temperature of 1000° an electric current passing from the copper to the iron heats the point of contact, while cooling it at the ordinary temperature. A knowledge of this fact, now for the first time demonstrated, may affect not only the theory of thermo-electricity, but also that of certain chemical phenomena.—Experiments made as a contribution to the study of the phenomena produced in man by the ingestion of the diarrhœic liquid of cholera into the stomach, by M. Bochefontaine. From these experiments, made on himself, as well as on the dog, guinea-pig, and other animals, the author feels justified in concluding that the reception in the stomach of the diarrhœic liquid containing the comma-bacillus of cholera does not neces-

sarily produce true cholera in man.—On the presence of the biliary salts in the blood of cholera patients, and on the existence of a toxic alkaloid in their dejecta, by M. G. Pouchet. The author, who is conducting a series of important experiments in the Hospital of Saint-Louis, Paris, concludes, so far, that the blood of cholera victims is certainly charged with a proportion, occasionally very considerable, of biliary salts, while their dejecta nearly always possess a strong alkaline reaction.—Letter on the application of the decimal system to the measurement of angles and of time, by the Minister of Public Instruction and the Fine Arts.—On a generalisation of the theory of mechanical quadratures, by M. Stieltjes.—On the reduction of the Abelian integrals, by M. H. Poincaré. It is shown that any system of Abelian integrals always differs infinitely little from a reducible system.—Note on the involution of superior dimensions, by MM. J. S. and M. N. Vanecek.—Note on an equation analogous to Kummer's equation, by M. E. Goursat.—A fresh demonstration of a theory of Jacobi respecting the decomposition of a number into four squares, by M. M. Weill.—On the laws of friction in mechanical appliances in connection with the experiments on the electric transmission of force about to be made between Paris and Creil, by M. Marcel Deprez.—On the construction of prototype standards of the legal ohm, by M. J. René Benoit. The International Conference of 1884 having defined the value of the legal ohm, the author describes some quicksilver standards representing the new unity constructed by him at the request of the Minister of Posts and Telegraphs.—Note on the indices of refraction of crystallised alums, by M. Ch. Soret.—On the chemical constituents of the rain-water that falls in the city of Algiers, by M. Chairy.—Remarks on the combustible carburetted compounds present in the terrestrial atmosphere, by MM. A. Muntz and E. Aubin.—Note on the trifluoride of arsenic, by M. H. Moissan.—On the reaction of ferric oxide at a high temperature on certain sulphates, by M. Scheurer-Kestner.—On ammoniacal ferment, by M. A. Ladureau. The author gives the results of experiments commenced three years ago for the purpose of determining the *rôle* and presence of this substance in Nature.—On the presence of amylase in the leaves of plants, by M. L. Brasse. The author has determined the presence of amylase in all leaves hitherto examined by him, including the potato, dahlia, maize, beetroot, tobacco, poppy, sunflower, &c.—On the employment of the cultivated yeast of wine for stimulating fermentation and shortening its duration, by M. A. Rommier.—Addition to a note on a crystallised pegmatite of chlorophyllite from the banks of the Vizézy, near Montbrison, by M. F. Gonnard.

BERLIN

Physical Society, October 24.—In former experiments with Helmholtz's leucoscope Dr. König had found that, while persons having normal trichromatic eyes saw the two images appearing in the field of vision differently coloured whatever the position in which the Nicol prism was placed, persons with so-called colour-blind or bichromatic eyes, on the Nicol prism being placed in a certain position, saw similar images. In the case of all so-called red-blind individuals the position of the Nicol prism was always the same, and differed from that in which green-blind persons saw like images. The leucoscope was, therefore, an instrument by means of which colour-blindness could be conclusively determined. For the practical requirements of eye-doctors, Dr. König had now so far simplified the leucoscope that it contained only a double prism, a lens, a quartz plate (of 5, 10, or 15 mm. thick), a Nicol prism, and a telescope. With the help of this simple instrument not only did it become easy to ascertain colour-blindness in practice, but it could likewise be determined whether any transitions occurred between red and green blindness. Among fifty colour-blind persons examined by Dr. Köng, he had not found a single case of such transitional form.—Prof. Neesen reported on the resumption of his earlier experiments regarding the influence of magnetisation on the electrical conductivity of fluids. The fluid conductor consisted of two tubes, a longer and a shorter, to which the current was transmitted by means of electrodes exactly alike. The tubes were combined into a bridge, and counterbalanced by the intercalation of metallic resistances. One tube was brought between the armatures of an electro-magnet, and the resistance measured alternately with and without the excited electro-magnet. When the tube was placed equatorially between the magnetic poles, the difference in the balance of the galvanometer was not greater than that produced on the galvanometer by the magnetising current alone (0·3 parts of the scale). With the tube placed in the axial position, on the other hand, the difference in the balance under an excited electro-magnet amounted to about 1 part of the scale, an effect which seemed to demonstrate a positive influence exercised on the conductivity by the magnetism, considering that the electro-magnet employed was not very powerful. It still remains necessary, of course, to determine by special experiments whether this change of resistance does not proceed from the influence exercised by the magnetism on the polarisation of the electrodes.—Dr. Kayser produced the lightning-photograph he had lately shown to the Meteorological Society (*vide* NATURE, vol. xxx. p. 652), and thereby gave rise to a somewhat lengthy discussion on lightning-discharges.—Prof. Eilhard Wiedemann of Leipzig communicated some results of an examination he had made into colloids, the relation of which to water, following up an earlier work on crystals and crystalloids, he determined with respect to their thermal behaviour. Lime on being brought into contact with water swelled, as was known, and that with evolution of heat. On dissolving slacked lime, on the other hand, in a larger quantity of water, heat became latent. Similar relations applied to other organic colloids, such as gelatine, starch, albumen, &c. The expansion of gelatine under heat Prof. Wiedemann found to be quite regular. At the melting-point of the colloids the curve of expansion showed only a very slight curvature convex to the abscissæ of temperature. When Prof. Wiedemann put some gelatine in a test-glass, and put on the top of it some small shot, and further placed a layer of gelatine over that, he saw, after heating, the shot slowly sink through the viscid mass to the bottom. If he now again spread some small shot on the top of the fluid gelatine, he again saw it sink slowly downwards. As soon, however, as it reached the place occupied by the previous shot before it sank to the bottom, its descent became much more rapid, as though the first shot had opened up a channel of lighter consistence in the gelatine which had been originally of the same consistence as the superincumbent gelatine.

CONTENTS

THURSDAY, DECEMBER 4, 1884

THE CHOLERA BACILLUS

IN view of the investigations which are going on at the present time, it will be of interest to our readers to summarise the reasons which Koch gives for his conclusion that the comma-bacilli described by him are the cause of cholera. No doubt can remain in the minds of those who have read his paper on the subject, published in the *Berl. Klin. Wochenschrift*, No. xxxi., 1884, and the discussion thereon, that he has devoted an immense amount of time and labour to the question, and that he has dealt with the subject in a most open-minded and conscientious manner. His known character for accurate observation and care in drawing conclusions lend great weight to his statements. We will give a short sketch of his arguments under a series of headings.

(1) The comma-bacillus is a specific micro-organism having marked characteristics distinguishing it from all other known organisms.

Their length is from half to two-thirds of that of tubercle bacilli, but thicker and slightly curved: this curve is generally not more than that of a comma, but sometimes it may be greater, forming even half a circle. Sometimes several bacilli can stick together end to end, giving rise to the appearance of a spirillum. Koch thinks that this organism stands midway between a bacillus and a spirillum. They grow rapidly in meat infusion. They possess the power of active motion. They also grow well in other fluids, in milk more especially. They increase rapidly in blood serum. A very good medium is Koch's gelatinised infusion (peptone, gelatine, meat infusion, made neutral by carbonate of soda), and its cultivation in this material "renders its detection easy and very certain." Shaken up with the liquefied gelatine, poured out on a sterilised glass plate, and kept at a temperature at which the gelatine becomes solid, its colonies are very characteristic: when young, they appear as small, very pale drops, not quite round, but more or less irregular and jagged in contour; they also have a granular appearance, and when larger look like a heap of strongly-refracting pieces of glass; the gelatine becomes fluid in the immediate neighbourhood of the colony, the latter sinks into the gelatine, and thus a small funnel-shaped depression is formed, in the middle of which the colony is seen as a small white point. The liquefaction of the gelatine does not extend more than about one centimetre around the colony. If a tube of solid gelatine is inoculated by dipping a needle in the cultivation, and pushing it into the gelatine, the latter becomes fluid first at the point of entrance of the needle; the colony sinks more and more; a funnel-shaped depression is formed with an appearance as if an air-bubble were present at the top. They can also be cultivated in a meat infusion containing peptone, neutralised and rendered solid by agar-agar. They grow on potatoes, forming colonies closely resembling those of the bacillus of glanders, but not so brown as the latter. They grow best at a temperature between 30° and 40° C.; below 16° C. they cease to grow; freezing does not kill them. They only grow in presence of oxygen. They grow very fast; their vegetation rapidly reaches its highest point: it remains stationary for a time, and then as rapidly ceases, the bacilli dying. They will not grow in meat infusion or the gelatinised material if it is at all acid. They die very rapidly when dried, not retaining their vitality longer than three hours. They do not form spores, corresponding in this respect with spirilla rather than with bacilli; Koch has made an exhaustive series of investigations to ascertain this point. Micro-organisms presenting all these characteristics are the bacilli described by Koch; organisms presenting only some of the characteristics, such as microscopical appearance, but differing in other points, are not Koch's comma-bacilli.

(2) This bacillus is always present in cholera.

Koch states that this bacillus is always present in cases of cholera. He determines its presence not only by microscopical examination, but by cultivation in gelatinised meat infusion. In ten cases in Egypt they were found microscopically (he had not then worked out their characteristics on cultivation). In India he made forty-two post-mortem examinations, and found them in all cases, by cultivation and microscopical examination, in the intestinal canal. The dejections of thirty-two cholera patients were also examined in the same way, and the comma-bacilli were found in all cases; also, in two cases seen in Toulon, and microscopically in sections of the intestinal wall in eight cases sent to him previously from India and Egypt. In almost 100 cases carefully examined these organisms were found, and that in cases occurring in various parts of the world.

(3) It is the only form which is constantly present in this disease.

(4) It is present in greatest numbers in acute and uncomplicated cases.

Koch has found that this is the case, and that on the other hand, in cases which live longer, the bacilli are fewer, and more especially where hæmorrhage or other complications have occurred, other bacteria are most numerous.

(5) It is present in the parts most affected.

According to Koch the lower part of the small intestine is that most affected by the disease, and here the bacilli penetrate into the tubular glands and also in part between the epithelium and basement membrane; in some places they penetrated even more deeply into the tissue. Where death of portions of the mucous membrane had occurred, other bacteria were also present in the tissue, but the comma-shaped ones were always deepest, "giving the appearance as if they had prepared the way for the others."

(6) It is never present in other diseases, in healthy persons, nor has it been found outside the body when no cholera was in the neighbourhood.

This is the keystone of the research, and naturally Dr. Koch has devoted great attention to this point. All his investigations in this direction have been carried out by his usual methods—chiefly by cultivation, aided also by the use of the microscope. He has thoroughly examined thirty bodies of patients who had died of dysentery, intestinal catarrh, "biliary typhoid," one case of ordinary typhoid fever, and several cases where ulceration of the intestines has been present. In none of these did he find comma-bacilli. He failed to find them in a number of cases where he examined the dejections of patients

suffering from dysentery, also in diarrhœa of children, in animals poisoned by arsenic, in impure water from various parts around Calcutta, indeed wherever he met with a fluid containing bacteria he examined it for comma-bacilli, without however finding any (except in one instance, see No. 8). He specially mentions that he has tested saliva and the material on the teeth and tongue, which is always full of bacteria, but always with a negative result. He further refers to his own previous large experience in the cultivation of bacteria, and that of others who have worked at cultivation, this experience being against the presence of this organism, except in cholera. From these facts he feels himself warranted in stating that "the comma-bacilli constantly accompany cholera, and are never found elsewhere."

(7) No other conclusion can be arrived at than that these bacilli are the cause of cholera.

(*a*) It might be said that the choleraic process merely favours the growth of this bacillus. But on this supposition every one must have comma-bacilli in his body, because they are present in cases of cholera occurring in widely-separated parts of the world. This, however, is not the case (No. 6).

(*b*) As the result of the disease, conditions arise which cause the transformation of some ordinary bacterium into comma-bacilli. There is no evidence of such rapid transformation of one form of bacterium into another. The only known case of alteration in the properties of these bodies is the attenuation of anthrax bacilli, &c., but this is merely an alteration in pathogenic action; their form and mode of growth remain unaltered. Outside the body Koch has not, during the course of his investigations, got the slightest evidence of any change in these bacilli.

(*c*) The only conclusion which remains is that the cholera process and these bacilli stand in close relation to each other—in a relation of cause and effect.

(8) Although by experiments on animals direct evidence that the comma-bacillus is the cause of cholera has not been obtained, there are various observations which are almost as good as experiments on man.

In one case in a village near Calcutta Koch examined the water of a tank which supplied the inhabitants with drinking-water, &c. A number of cases of cholera had occurred, and when the water was examined the epidemic was at its height. Comma-bacilli were found in the water in considerable numbers. At a later period, when there were only few cases of illness, the comma-bacilli were few in number, and only found at one part of the tank. This was the only instance in which Koch found these bacilli outside the body. He further refers to the occurrence of disease in washerwomen, and infection from clothing soiled with cholera dejecta.

(9) The natural history of the disease corresponds with the various characteristics of this organism.

The bacilli grow rapidly, soon reach their highest point of development, and then die: this corresponds to what occurs in the intestinal canal. Under ordinary circumstances these bacilli are destroyed in the healthy stomach. This corresponds to the clinical facts of cholera, for, of a given number of individuals exposed to cholera, only some are taken ill, and those almost all suffer from disturbance of digestion—either catarrh of the stomach or intestine, or overloading of the stomach, &c., with indigestible food. The disease dies out in places where the conditions for its continuance are unfavourable: the bacilli have no spores.

These are the facts on which Koch's views are based; lately, however, two researches have been published which strike at the root of the theory, and which try to show that these bacilli are not peculiar to cholera. Dr. Koch has also published a reply.

The first of these researches is that of Dr. Lewis, who finds bacilli in the mouth microscopically identical with the comma-bacilli. Koch's reply (*Deutsche Med. Wochenschrift*, No. 45, 1884) is that he is well aware of the fact that organisms somewhat resembling the cholera bacillus are present in saliva, but that he does not diagnose these bacilli by microscopical characters alone, that if these bacilli are cultivated they will be found to be quite different from those present in cholera. For instance, they will not grow at all in the neutralised cultivating gelatine in which the cholera bacilli grow rapidly. The other research is by Finkler and Prior, who stated that they had found the comma-bacillus in cases of cholera nostras, and who further described spore-formation in them. Koch succeeded in obtaining a specimen of their "pure" cultivations, and found, on shaking up a minute quantity with the liquefied gelatine and pouring it out on a glass plate, that they had a mixture of four different bacilli, and that none of them were the comma-bacilli described by him.

Koch further adds the interesting fact that he has again taken up the experiments on the lower animals (presumably, from the context, on dogs and guinea-pigs), and that by injecting minimal quantities (as little as the 100th of a drop) of the cultivations of comma-bacilli into the small intestine, the animals have as a rule died in one and a half to three days, and the post-mortem appearances of the intestine were the same as in acute cases of cholera, the fluid in the intestine also containing enormous numbers of comma-bacilli.

In two cases of cholera nostras, and in a diseased bee, the writer found bacilli which microscopically closely resembled the comma-bacilli, but it was found that they did not grow in the neutralised gelatinised material, and were therefore not the same organism.

THE HAYTIAN NEGROES

Hayti; or, The Black Republic. By Sir Spenser St. John, K.C.M.G. (London: Smith, Elder, and Co., 1884.)

WHATEVER theory may be adopted regarding the fundamental equality or disparity of the human races, a truthful and unbiased account of the present social condition of the Haytians, by a competent observer, must necessarily prove a valuable contribution to the study of psychological anthropology. These conditions are eminently satisfied in the work before us, written as it is by a man personally above suspicion of any unworthy motive, by a statesman who has associated for some five-and-thirty years with every variety of coloured peoples, by a distinguished diplomatist, who, as British Minister and Consul-General, has resided for twelve years in Hayti itself. On the other hand, no more favourable field could be selected for a study of the negro race than this western and smaller division of this large West Indian island,

second in size only to Cuba, of which it forms a natural continuation eastwards to Porto Rico. Here the eastern and much larger division, known as Santo Domingo, has been mainly in the hands of a "coloured," that is, negroid or mulatto people, since the expulsion of the Spaniards and French early in the present century. But in Hayti the pure negro has always been in the ascendant, and his policy has persistently been to get rid of the white and coloured elements. The whites disappeared, either exterminated or driven into exile, during the struggle with France; and of the present population, roughly estimated at some 800,000 or 900,000, not more than one-tenth are mulattoes, and all the rest full-blood Africans. The Haytians may, in fact, be regarded as a section of the negro race transplanted bodily to their present domain, where they have had it all their own way since the close of the last century. Whatever differences may exist, are all in their favour; for they here find themselves separated from the old baneful associations, and surrounded on all sides by the civilising influences of more cultured peoples. The physical environment is also more favourable, the climate being on the whole decidedly superior to that of the African sea-board, while the well-watered lowlands are described as amongst the most fertile tracts on the globe.

And what is the outcome of fully three generations of political autonomy under these exceptionally advantageous conditions? Practically a reversion to, or, more correctly speaking, an almost uninterrupted perpetuation of, the African tribal organisation in its very worst aspects. Such is the general conclusion conveyed by a careful study of Sir S. St. John's work, which may be briefly described as a formidable indictment against the negro race as such, and a crushing reply to those sentimental philanthropists who go about preaching the doctrine of the inherent equality of all mankind. In a few well-digested chapters he deals comprehensively with the history, government, trade, industries, and social institutions of the "Black Republic," and on all these branches of the question his verdict is in the highest degree adverse. "I could not but regret," he writes, "that the greater my experience the less I thought of the capacity of the negro to hold an independent position. As long as he is influenced by contact with the white man, as in the southern portion of the United States, he gets on very well. But place him free from all such influence, as in Hayti, and he shows no sign of improvement. On the contrary, he is retrograding to the African tribal customs, and without exterior pressure will fall into the state of the inhabitants of the Congo. I now agree with those who deny that the negro could ever originate a civilisation, and that with the best of education he remains an inferior type of man. He has as yet shown himself totally unfitted for self-government, and incapable as a people of making any progress whatever. To judge the negroes fairly, one must live a considerable time in their midst, and not be led away by the theory that all races are capable of equal advance in civilisation" (pp. 131-132).

This general conclusion is amply supported by overwhelming evidence collected at first hand by a shrewd observer, whose official position enabled him to obtain accurate information regarding every phase of Haytian political and social institutions. That the successive "empires" and "republics" were mere burlesques; that the administration of justice has always been a farce; that civic virtues are absolutely unknown; that, in a word, "politically speaking, the Haytians are a hopeless people" (p. 133), will probably be accepted without demur by the intelligent reader. But that fetish worship, cannibalism in its most repulsive forms, and all the abominations associated with the secret "Vaudoux" rites, are still rampant, and encouraged if not actually practised by the very highest State functionaries, including Presidents themselves, would certainly be received with a smile of incredulity, were the facts not attested by evidence of the most unimpeachable character. Even so the revelations made in connection with this loathsome subject almost exceed the bounds of belief, and could not be accepted, were we not assured that they are "founded on evidence collected in Hayti, from Haytian official documents, from trustworthy officers of the Haytian Government, my former colleagues, and from respectable residents—principally, however, from Haytian sources" (Introduction).

To the question, Who is tainted by the Vaudoux[1] worship? the answer is, "Who is not?" Yet a prominent feature of this horrible cult is the sacrifice of "the goat without horns," that is, of some human victim, often supplied by the parents themselves, who also share in the feast at which their murdered offspring is devoured. At a trial held in 1864, four women were convicted on their own confession of having killed and eaten a girl, six years old, delivered to them by the aunt, and of feeding up another child to be sacrificed and eaten on the Feast of the "King of Africa." A Spanish official present at the trial reported that, if the public prosecutor had done his duty, "not only the witnesses but the mother of the victim herself would have shared the fate of the cannibals proved guilty of having eaten her." Another woman, reproached with having devoured her own offspring, retorted, "And who had a better right? Est-ce que ce n'est pas moi qui les ai fait?" And in 1878 a case came under the notice of the author, in which two women were caught in the act of eating the flesh of a child raw. "On further examination it was found that all the blood had been sucked from the body" (p. 225).

In common with many other observers, the author noticed "that negro boys up to the age of puberty were often as sharp as their coloured fellow-pupils," adding that "there can be no doubt that the coloured boys of Hayti have proved, at least in the case of one of their number, that they could hold their ground with the best of the whites" (p. 266). But it is equally certain that after reaching puberty further progress appears to be arrested, so that the negro remains intellectually a child to the last. This remarkable phenomenon is probably due to the premature closing of the cranial sutures in the negro race, as suggested by Filippo Manetta, who also noted the sudden arrest of development in adults. "The intellect seemed to become clouded, animation giving place to a sort of lethargy, briskness yielding to indolence. Hence we must needs suppose that the evolution of the negro and white proceeds on different lines. While with the latter the volume of the brain grows with the expan-

[1] Apparently a corruption of the West African word *Vodun*, implying a species of ophiolatry, in which the great serpent, an all-powerful supernatural being, on whom all things depend, is worshipped by secret rites, nocturnal orgies, and human and animal sacrifices.

sion of the brain-pan, in the former the growth of the brain is on the contrary arrested by the premature closing of the cranial sutures and lateral pressure of the frontal bone."[1]

The chapter on the curious French Creole patois current amongst the Haytians will be found instructive by students of such jargons. Its euphonic laws and peculiar structure, or rather absence of structure, are illustrated by a number of passages from popular songs and proverbs, such as the characteristic—

> "Négue riche li mulatte,
> Mulatte pauvre li négue."

That is—

> "Negro enriches mulatto,
> Mulatto impoverishes negro."

Beyond oral compositions of this sort there is no local literature, and the public records, diplomatic communications, and correspondence of all sorts are written in more or less grammatical French. None of the full-blood blacks have aspired to the honours of authorship, or attempted any sort of literary composition beyond an occasional political essay or manifesto. In this as in all other respects there seems to be an impassable gulf even between them and the coloured portion of the population.

The book is furnished with a useful map of Hayti; but there are neither illustrations nor index.

A. H. KEANE

[1] "La Razza Negra nel suo stato selvaggio, &c." p. 20. (Turin, 1864.)

OUR BOOK SHELF

Hilfsbuch fur den Schiffbau. Von Hans Johow. (Berlin: Julius Springer, 1884.)

THIS handsome volume belongs to the class of publications known as "pocket-books," of which there are many examples, in English, adapted to the use of various branches of engineering. It is essentially a compilation of facts, formulæ, and methods likely to prove useful to ship-builders in the course of their ordinary work; and it will bear favourable comparison with anything of the kind previously published. In the range of its information, and the extent as well as variety of the sources drawn upon, Mr. Johow's book surpasses all others intended for the use of ship-builders; evidencing wide research and a thorough acquaintance with the literature of the profession. It cannot fail to prove valuable as a book of reference in the offices of all ship-yards, and should be of great assistance to draughtsmen, especially in carrying on calculations or details of design.

Tbe arrangement of the book is excellent, and it is admirably produced, the numerous tables and diagrams, as well as the mathematical investigations, being clearly printed and easily followed in reading. This has been accomplished without making the volume large or expensive. Five principal sections embrace the contents.

The first section contains a mass of general information and tables, designed to facilitate reference and save labour. In the mathematical subdivision of this section appear tables of the squares, cubes, square root, cube root, &c., of numbers up to 1000; trigonometrical tables; algebraical and trigonometrical formulæ of various kinds. Another subdivision deals with "mass and weight," giving full particulars of the weights and measures of various countries, and tables for conversion of one system to the others. Tables of weights of materials follow, and are very extensive and well arranged; in addition, there is a brief summary of the principles of strength of materials, including Wöhler's valuable investigations on the "fatigue" of metals. Brief chapters are also devoted to the theory of heat, chemistry, and galvanism; and finally a good deal of information is given on details of design, fastenings, &c.

The second section deals with the theory of ship-building. It gives particulars of various systems of mechanical construction for the forms of ships; deals with the problems of buoyancy and stability, and describes methods of calculation; gives approximate formulæ for use in preliminary investigations; and deals in a practical fashion with ocean waves, propulsion of ships by sails, the action of the rudder, fluid resistance, and propulsion by steam power. Under the last heading appears a most comprehensive summary of the various methods proposed for approximating to the engine-power required to give steamships their assigned speeds. Lastly there is a chapter on compass-correction.

The third section deals with more practical questions relating to the lading and freeboard of ships; their outfit of anchors, chains, boats, pumps, &c.; the armaments of war-ships; the methods of testing materials used in ship-building, &c.

In the fourth section are contained detailed information relating to the propelling machinery, boilers, and propellers of ships; the rules of the Board of Trade for boilers; and tables, &c., for use in trials of speed.

The fifth and last section contains details of the laws and regulations affecting German and foreign shipping, various rules for calculating tonnage, and our Board of Trade regulations for passenger-steamers. An excellent index concludes the book.

It cannot be supposed that such a great mass of information has been brought together and greatly condensed without some sacrifices and possible errors; but the author has evidently taken pains to insure accuracy, and his book should command a wide circulation both in Germany and abroad.

W. H. W.

A Synopsis of Elementary Results in Pure and Applied Mathematics: containing Propositions, Formulæ, and Methods of Analysis, with Abridged Demonstrations. By G. S. Carr, M.A. Vol. i., Sections x., xi., xii. (London: Francis Hodgson, 1884.)

OUR notices of the former sections will be found in vol. xxii. (p. 582) and vol. xxvi. (p. 197). These sections are occupied with the Calculus of Variations (pp. 441 to 459), Differential Equations (pp. 460 to 545), and the Calculus of Finite Differences (pp. 546 to 560). In the first section we have not detected any mistakes of any importance, in fact only one or two typographical faults. The second section commences with an unfortunate slip in the numbering of the articles, which is not pointed out until the next sheet is commenced (p. 473). In this section there are numerous errata, of which we indicate a few. In § 3276 the first term in the last line should have the mark of differentiation with regard to x affixed. We note mistakes in §§ 3342, 3382, 3392, 3394, 3399, 3407, 3431, 3447, 3499, 3520, 3521, 3537, 3570. These corrections are mostly for wrong references, and the articles are cited for the benefit of students. The last section appears to be quite right, with the exception of a typographical error in § 3703. We have not undertaken to work out and verify each article, but we have gone through each, and the above small list of mistakes will give an idea of the care exercised in the editing of this part. We repeat our former advice, viz. that a student who wishes to refer to the "Synopsis" for refreshing his knowledge of the above-named branches should at the time of his reading his text-book have this manual by him for verification. The sections are mainly based upon Jellett (for Variations), and Boole (for the two latter sections).

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Natural Science for Schools

I WAS glad to see that "Science Master" had pointed out some of the difficulties in the way of applying the principles laid down in Prof. Armstrong's valuable paper in your number for November 6 (p. 19). The difficulties to which he has adverted relate mainly to those gratuitously thrown in the way of sound and useful practical teaching in grammar-schools by boards of examiners. Another difficulty I ventured to point out in the brief discussion upon Prof. Armstrong's paper at the Educational Conference of the International Health Exhibition, but it did not receive the attention which I think it deserved—partly, perhaps, owing to press of business, and partly, perhaps, also to the fact of the naturally somewhat strong representation of South Kensington interests at a conference held within the shadow of the Brompton Boilers. Prof. Armstrong appeared specially to recommend his mode of teaching "in science classes, such as those held under the auspices of the Science and Art Department," and towards the end of his paper he seems to recognise only one difficulty in the way of introducing it generally, viz. it "undoubtedly involves more trouble to the teacher than that ordinarily followed," and he appears to hint that the present method is mainly due to the incapacity of the teacher, as he says, "I do not believe that it is because the Department consider it" (the system) "a satisfactory one; but they know full well that it would be unwise to legislate far in advance of the intelligence and powers of the majority of the teachers." There are many teachers who are only too anxious to teach, not chemistry merely, but physics and other branches of science upon a sensible system, and who would willingly take considerable *trouble* to attain that end, but the difficulty is that, were they to do so, they would not get paid for their work. The insane system of *payment by results* is responsible for the greater part of the bad and indifferent teaching of science in this country, and the real trouble is, not that something better is in advance of the intelligence and powers of the majority of *teachers*, but that it is in advance of the intelligence and powers of the majority of *examiners*. The Department accept as their primary axiom that no teaching is to be paid for except that which can be exactly tested and appraised by certain examiners; and so no teaching, whatever its educational value, is counted worth anything by them except that which is susceptible of being weighed and measured. I took the liberty at the discussion of asking Prof. Armstrong whether he had ever taught a class on his methods, and if that class was presented to the Department for examination, and if so what was paid for it, and I made bold to express my own opinion that the result would be either *nil* or despicably small. My question received no answer, but I got plentifully snubbed—firstly, that a science teacher should even think of such a subject as remuneration, and secondly, I was informed that practical teaching always paid best. But as it appeared that my critics had misapprehended the point at issue, and were not speaking of the kind of teaching advocated by Prof. Armstrong at all, but thought that *practical* teaching meant allowing the class to see certain experiments performed by the teacher himself—a mode of teaching which I am quite agreed with the reader of the paper in considering quite *unpractical*—I did not feel satisfied that my question was answered, and with your permission will again propound it. It is not a sufficient answer to say that the most practical teachers earn the best results—I am a science teacher of quite sufficiently long experience to know that—*provided it is strictly on the lines laid down by the Department*. What I doubt is whether *sensible* practical teaching would produce any pecuniary results.

Certainly, in what is called (*lucus a non lucendo*) practical chemistry it would not: there nothing but test-tubing can be weighed and measured; and whereas in former years a knowledge of the modes of preparing and experimenting with certain of the more common elements and compounds counted for something in the elementary stage, it has lately, by successive alterations in that direction in successive issues of the Directory, become more exclusively test-tubing.

In physics I presume the intelligent teacher would be glad to teach his class in light, heat, and sound, to make some of the more important measurements, to verify the laws of reflection and refraction, to measure the refractive index of glass, to calculate the foci of various lenses, to determine the latent heat of water and steam, and the specific heat of one or two substances and a few other similar things, not many of which could be introduced in a course of thirty lessons of one hour each; in electricity and magnetism, to establish the laws of intensity, to construct an electroscope, a galvanometer, and a Wheatstone's bridge, to measure the resistance of a few lengths of wire, to determine the E.M.F. of a "cell," &c., in which case the same limits would soon be reached. But would such a course pay? I venture to say not, and the Department have not even given to practical physics the scant encouragement which they afford to so-called practical chemistry. I say *scant encouragement*, because, by a series of red-tape regulations, which are strictly adhered to, they do their best to render the study of practical chemistry needlessly expensive to the committees and unremunerative to the teachers.

I shall probably be told—firstly that the teacher of a science class has no need to limit himself to thirty hours for a course; and secondly, that he should not make remuneration his first consideration. On the first point I reply that he is practically limited in most cases by the length of time during which it is possible to get students to attend: the month of September is as early as it is practicable to commence a course, and the examinations are early in May, so that one lesson a week, allowing for necessary holidays, cannot much exceed thirty lessons. To give two lessons per week would be to occupy the time of two classes for the remuneration—generally poor enough—of one; this, of course, virtually brings us to the second point, as to which I would say that, as in other professions men do not work for inadequate remuneration, I do not see why the science teacher should be expected to be more philanthropic; that neither the clergyman, the lawyer, nor the physician professes to regard money as his chief consideration, yet that the remuneration of each of these professions is far before that of the science teacher, at all events of him who works for the Science and Art Department; and lastly, that that particular line of criticism does not usually come from those who are themselves working from philanthropic motives, but from those who are pretty well paid for their labours, and who would despise the modest reward of the "*payment by results*" teacher.

I hope I shall not be misunderstood as disagreeing with Prof. Armstrong's views; it is, on the contrary, because of my full agreement with them and that I am anxious that those science teachers who are sufficiently advanced in intelligence (and I am persuaded that they are not so rare as Prof. Armstrong seems to think) to adopt a truly educational mode of teaching, should have no needless obstacles thrown in their way, that I venture to address you and to repeat before a larger audience those arguments which I made use of before the smaller auditory at the Health Exhibition.

I for one should be only too glad to see the scope of the science teaching under the Science and Art Department widened, and to know that encouragement was given to the intelligent and advanced teacher to get out of the grooves in which it appears to be the present policy of that Department to retain him.

WALTER A. WATTS

Farnworth Grammar School, November 20

Do Flying-Fish Fly?

I CANNOT pretend to the great experience of Mr. R. W. S. Mitchell in observations on aërial movements of the flying-fish when for a brief space he leaves his native element; but during one voyage from the Isthmus of Panama to England *viâ* the West Indies I lost no opportunity (of many) of watching these beautiful creatures, sometimes very close indeed to our steamer. The opinion I formed at the time and still retain was that there was constant very rapid motion of the great lateral fins whilst out of the water, so rapid, indeed, that the strokes of the fins could not be counted. From what Mr. Mitchell says, he evidently counted the strokes of the wings (pectoral fins), not by seeing the movements of these, but by the "impressions made on the oily surface of the water," impressions apparently similar to those made by a cormorant or other diver when taking wing from the sea.

The movements of the side fins whilst the fish was in the sea or touching the surface, would be much slower than would be the

case when it was wholly in the air, because, to be of any use then, the strokes would have to be so rapid as to be scarcely countable, as is the case with certain sea fowl (notably auks) which use their wings (with a comparatively slow stroke) whilst swimming *under* water, but when flying move them so rapidly that the strokes can either be counted with difficulty or not at all. On watching flying-fish whilst in the air, I noticed a flickering of the fins, indicating what I believe to have been rapid motion.

As Mr. Mitchell's observations, on which he chiefly relies, were made when looking down from the high bows of a steamer, the "waving from side to side" of the tail of the fish, being a lateral motion, was clearly seen, whilst the movements of the side fins would be less easily discernible.

Finally, could the impetus acquired by the fish, when springing from the water, carry it through the air "50 or 100 yards" (Mr. Mitchell's estimate) without the aid of any additional propelling force during its fight? If so, the initial velocity must have been very great. JOHN RAE

4, Addison Gardens, W., November 27

The "Jeannette" Drift

IN NATURE of November 20 (p. 66) you give an account of the finding of some relics of the *Jeannette*, which have been picked up on an ice-floe at Julianhaab, in lat. 61° N., long. 46° W., near the south point of Greenland, and which must have drifted from the New Siberian Islands in lat. 75° N., long. 155° E., where the *Jeannette* was squashed three years ago. This I consider a most important find with regard to Arctic navigation and discovery. The question arises, How did the ice-floe get to Julianhaab? I propose the following solution. The Siberian Islands bear nearly due north from Julianhaab, and in a straight line up Davis's Strait, Baffin's Bay, Smith's Sound, Lincoln Sea, &c., and across at a distance of about 250 knots from the Pole. I think it most probable that the floe may have drifted through "the unknown," or what Osborn calls "the land of the white bear," the large unexplored area to the west of Banks's Land, and have got into Baffin's Bay through one of the sounds on its west coast—either by Jones's Sound, where the tide runs eastward at the rate of two knots an hour ("Inglefield," p. 77), or by Banks's Strait and Lancaster Sound.

We know that the icebergs come *down* Baffin's Bay and Davis's Strait into the Atlantic, and the floe has had fair success in navigating through a distance of 2700 knots to reach Julianhaab in three years.

I cannot for a moment suppose that this ice-floe has come from the Siberian Islands, *viâ* Francis Joseph Land, Spitzbergen, Iceland, to Greenland, a distance of 3600 knots, for that course would have been directly *against* the Gulf Stream, in which no floe could last three years, even if it were 26 feet thick, as Inglefield found them in Jones's Sound, or 40 feet thick, as McClure found them in Banks's Strait. McClure found the current west of Point Barrow going 2 knots per hour to the south, evidently making for Behring's Strait, while of the north-west point of Banks's Land the drift was north-east 1 knot an hour, evidently going towards Lancaster Sound.

I therefore conclude that the *Jeannette* relics could not have come westward, they *must* have come eastward, and this proves that there is a course open which is unknown to us.

I would suggest that a number of very strong buoys, capable of resisting ice-pressure, should be set adrift on ice-floes on various parts of the Siberian coast, each numbered indelibly, so that when recovered it could be ascertained whence they started, and their course *might* possibly be ascertained from the Eskimo, who may have seen them, or by other means. This experiment is worth a trial. R. S. NEWALL

Ferndene, November 30

A Meteor Visible in the Daytime

AT Waterpark, just below Waterford City, about 4 p.m. on October 15, my attention was attracted by a flash of increased light. Looking up, I saw in the south-south-west, about half way between the horizon and the zenith, a bright meteor slowly sailing nearly due west, its apparent size about half that of the full moon, intensely white in colour at the centre, passing into blue at the circumference. It described a low arc, and was in sight for several seconds, leaving a trail of indigo blue with lighter luminous edges. The meteor disappeared behind some clouds which concealed the sun at a considerable altitude above the horizon. JAMES GRAVES

November 27

Noon-Glow

WHILE waiting at the telescope shortly before noon this date to note place of sun-spots at meridian passage, masses of cloud formed suddenly in a clear sky overhead, and drifting slowly due south, obscured a peculiarly brilliant sun. No sooner had direct light been intercepted than the upper air above cloud and sun's place appeared filled with the latterly common white glare (as of attenuated peat-smoke highly illuminated), which soon became suffused with the now familiar rose-tint, apparent also between the clouds and on south-south-west horizon, but not beneath the sun on meridian. The sun's apparent meridian altitude being 16°, the superior limit in altitude of rose-tint was 39°; the colouring being monotone throughout, and not to be confounded with that of halos. Fearing ocular deception, as often happens from fatigue of eyesight, I asked an intelligent companion to verify observation, more especially as the diffused white glare at first slightly masked the tinting as compared with that of other "glows." It seems, however, plain that the terms "fore-glow" and "after-glow" no more cover the entire field than the Krakatoan dust. D. J. ROWAN

Kingstown, November 24

Rosy Glow about the Moon

AFTER watching for some time this evening a lovely twilight in the west, which though bright and luminous was not remarkable for strong colour, I turned toward the south-east, when the moon, now well up, was shining through detached fleecy clouds, and was surprised to see about her a rosy-coloured glow, very like that so often seen about the sun; the nearer clouds, though very high, telling as a cold almost greenish grey upon it. This glow, of course, was much lower in tone than that about the sun, but both in character and extent just like it, and quite distinct, and broader than those prismatic hues often seen about the moon, and called by sailors "cock's eyes" or peacock's-eyes. This was at 4.45 p.m., and as the twilight faded the glow disappeared, from which I infer that it was caused by vapour lying high enough in the south-east to catch some of the very last rays of the sun, but too far east to give a glow in the west.

I see that a correspondent of the *Standard* telegraphed that on the evening of the 25th "a sunset equal in splendour to those of last autumn was seen over the Yorkshire wolds. The predominating hue was a rich crimson." The weather here was cloudy that evening, but between narrow openings in the clouds the sky was the colour of rich painted glass of a ruby-red tint about 4.30 p.m. ROBERT LESLIE

6, Moira Place, Southampton, November 28

Wild Fowl Decoy

MAY I ask if any of your readers who are interested in wild-fowl decoys will send me the names and positions of any past and present ones they may happen to know or have heard of. I am endeavouring to save the history of decoys from oblivion, and though I have many hundred letters, maps, and sketches connected with this interesting subject, still I may have a great deal of information yet to obtain. I think the subject deserves a standard work, or I would not trouble you.

RALPH PAYNE GALLWEY

Cowling Hall, Bedale, November 24

Prehistoric Man

DURING October last, the sanitary authorities of Gloucester City had occasion to make some excavations in the timber-yard of Messrs. Booth and Co., and in the Bristol Road adjoining this yard, for the purpose of laying down a new sewer. In the course of this operation the workmen disinterred, from a bed of plastic clay, three human skeletons, occupying a position which appears to suggest that the remains in question are probably those of prehistoric man.

Arriving accidentally on the spot some two or three days after the actual find, I learned, to my great regret, that the skulls, two of which had passed through my friend Mr. Wm. Booth's

hands, had been cast on one side, reduced to fragments, and finally buried in the concrete foundation of the new sewer, no one supposing that the discovery represented anything more than some modern interment.

My friend had, however, seen one of the skeletons complete and *in situ*, extended at full length, face downwards, in the clay, while I succeeded in gathering a basketful of bones, including fragments of four left-hand femora, thus, probably, attesting the presence of more individuals than the number to which the workmen deposed.

Some of these bones I extracted from the clay itself, the remainder being found among the excavators' ejecta. Almost all of them are broken and have their cavities, even the spongy tissues and diploë of the cranium, completely filled with the clay in which they were discovered. They are easily broken into fragments by hand, have little organic matter remaining in them, and a few exhibit indications of having been gnawed by animals.

The clay-bed itself showed no signs of disturbance, such as would indicate a burial. On the contrary, it was evident that the bones had been quietly covered with river deposits as they lay, and, although near each other, the skeletons did not occupy a common resting-place.

The remains occurred at a depth of 5 feet 6 inches below the surface, 36 feet above Ordnance Datum, and 3 feet above the highest known modern flood-line, given on the authority of Mr. Martin, engineer to the Severn Navigation Commissioners.

It is clear, therefore, that the clay-bed in question must have been deposited at a time when the River Severn ran, and its flood-loams were laid down, at levels higher by many feet than those of the present day, or, in other words, at some time antecedent to the historic period, during which there is no reason to suppose that our rivers ever met the sea except at existing horizons. DANIEL PIDGEON

Holmwood, Putney Hill, November 22

Fly-Maggots Feeding on Caterpillars

AFTER Mr. McLachlan's remarks in NATURE for November 20 (p. 54), on Dr. Bonavia's note upon the above subject, it is hardly necessary to say that your correspondent, F. N. Pierce (November 27, p. 82) is undoubtedly mistaken in saying that he has bred the house-fly, *Musca domestica*, from Lepidopterous larvæ. If he has really bred *Musca domestica*, it is a new fact, and I should be very glad to see a specimen. I have had some considerable experience in breeding Lepidoptera, and have frequently bred out Dipterous parasites; these have invariably been *Tachinids*, mostly of the genus *Exorista*. To the ordinary observer they very closely resemble *Musca domestica*, but the same observer would very probably call all the various species of *Musca*, *Anthomyia*, *Homalomyia*, *Stomoxys*, &c., which frequently occur in houses, "house-flies." The general appearance of many of these genera is very much the same, and the term "house-fly" is such a vague one that I remember a good microscopist once showed me a slide labelled "upper and lower wing of house-fly"! some Hymenopteron caught on a window apparently furnishing the materials.

The Diptera are unfortunately much neglected in this country, and many groups are very little known. This is especially the case with the *Tachininæ*, and Lepidopterists who breed them would benefit science by pinning the specimens and sending them to one or other of the few students of this order of insects.

4, East Street, Lewes, November 29 J. H. A. JENNER

YOUR correspondent, Mr. F. N. Pierce, in NATURE for November 27 (p. 82) merely continues the error suggested by Dr. Bonavia's note on this subject. It is not the larvæ of the house-fly (*Musca domestica*) that he has found as parasites on his butterfly and moth caterpillars, but the larvæ of a *Tachina*, a Dipterous genus of the *Muscidæ*, too well known among even mere collectors, I should have thought, for such a mistake to be made. There is of course a superficial resemblance.

M. E. S.

The Forbes Memorial

MAY I make use of your widely circulated pages to say that I purpose in a few days to send to press a list of the subscribers to the Forbes Memorial, to be bound up with the issue of the zoological memoirs of our lamented friend; the Memorial Volume is now nearly ready, and I shall be glad to hear from any of the friends of Mr. W. A. Forbes who have not already communicated with me on the subject. May I add that it was agreed by the Committee that subscribers should receive a copy of the volume for every guinea subscribed.

F. JEFFREY BELL

5, Radnor Place, Gloucester Square, W.

THOMAS WRIGHT, M.D., F.R.S.

IT is perhaps hardly sufficiently recognised how much the progress of science has been helped by the leisure-hour occupations of busy professional men. No branch of science has profited more from this source than geology, and no calling has furnished so many helpful labourers as medicine. The career of Dr. Wright, whose recent death is so sincerely regretted, supplies one of the most notable examples of a life apparently absorbed in the laborious duties of a medical practitioner, yet wherein time was found for the pursuit of a long series of original and valuable researches in palæontology. To those who knew him only as a doctor, it might well seem that his whole time and thought were given to the duties of his medical practice. Those, on the other hand, who met him as a geologist and palæontologist could hardly realise that he had any other occupation than the study of the fossils which he treasured and described with such enthusiasm.

Dr. Wright was born in Paisley in 1809. Having a near relative engaged in the practice of medicine, he chose the same profession for himself, and received the earlier part of his education at Glasgow. Before he had completed his studies, he was induced to quit medicine and take part in the development of the manufacturing arts, then making rapid strides in Scotland. But finding the change unsuited for his temperament he turned back with a sense of relief to the profession he had abandoned, resumed his medical studies in Dublin, and finally graduated in 1846. Soon thereafter, circumstances led him to settle in Cheltenham, where he has since spent the whole of his long and honoured life. His devotion to the healing art, and his bent towards a scientific treatment of his subject, were soon recognised, and he became successively attached to the Dispensary and General Hospital, and finally Medical Officer of Health for Cheltenham and surrounding districts. He was twice married, and leaves a son and two daughters by the second marriage.

In the early days of his career Dr. Wright manifested his love for scientific investigation. While still a student in Dublin he devoted himself with ardour to the study of human anatomy, and especially to the application of microscopic research in that department of inquiry. His eyesight, however, not proving strong enough to bear the strain of microscopic work, he finally exchanged that pursuit for the cultivation of palæontology, which from the position of Cheltenham in the midst of richly fossiliferous rocks, lay temptingly open to him. Ranging over the abundant organic remains of the Lias and Oolites of his neighbourhood, he chose the Echinoderms as his special subject, and began to publish the results of his observations. His early papers gained for him the friendship and co-operation of Edward Forbes. It was arranged that the two naturalists should conjointly describe the Echinoderms of the British Secondary formations, Forbes taking the Cretaceous, and Wright the Jurassic forms. The former did not live to carry out his part of the programme, which was accordingly completed by his colleague. The monographs on the Secondary Echinoderms were published by the Palæontographical Society, and form an enduring monument of Dr. Wright's patient and minute research. But while engaged in these investigations, he did not neglect other departments of Jurassic palæontology. In particular, he devoted himself with

unwearied industry to the collection and comparison of the Cephalopods of the Lias, and at length, after some forty years of preparation, began his great monograph on "The Lias Ammonites," a work of much research, of which the concluding part is about to be issued, and which forms an enduring landmark in the history of English palæontology. In the course of the inquiries rendered requisite for this exhaustive treatise, he not only made himself acquainted with the fossil localities and public and private collections in this country, but paid visits to many parts of the Continent to study the contents of foreign museums and to confer with his fellow-labourers in the same field scattered over France, Switzerland, and Germany. He was engaged, at the time of his death, upon a monograph of British Cretaceous Starfishes, which he had nearly completed.

The value of his scientific work has been fully recognised by his contemporaries. He was early elected as a Fellow of the Royal Society of Edinburgh. Subsequently he joined the Geological Society of London, and from that body eventually received its highest honour—the Wollaston Medal. In 1879 he was elected into the Royal Society. He was President of the Geological Section of the British Association at the Bristol meeting in 1875. His published papers and memoirs are numerous, but the largest and most important are his monographs in the publications of the Palæontographical Society.

It was not alone by original research that Dr. Wright strove to foster the progress of his favourite science. As one of the fathers of the Cotteswold Field Club, as President of the Literary and Philosophical Association of Cheltenham, as a frequent lecturer on scientific topics not only in Cheltenham, but in Bristol, Bath, Worcester, and other towns; and generally by the enthusiasm with which, amid all the obstacles of his busy professional life, he contrived to find leisure for the cultivation of science, he was unquestionably one of the living forces that stimulated the growth of science all over the West of England. His death is therefore a serious deprivation, and will be mourned by all in that region to whom scientific progress is dear.

To a narrower but still a wide circle his removal from among us is the loss of a leal-hearted friend. Those who were thus privileged will cherish the memory of that cheery face with the bright twinkle of eyes that were as brimful at one time of merriment as, at another, they were suffused with sympathy; the joyous laughter that rang out clear and strong from a heart in which there was no guile; the earnest brow and hand upturned behind the ear as the talk went on over his favourite pursuits; the bursts of enthusiasm as some new fact or novel deduction dawned on him, and the play of humour that was ever ready to break out like a beam of summer sunshine. Dr. Wright made his final expedition in August last year, when he joined the writer of these lines in the Island of Arran. Already the symptoms of his fatal malady had shown themselves, and he knew what they foreboded. But he carried with him nevertheless his characteristic sunniness of nature. Seated on the bare mountain-side with the purple heather and yellowed bracken around him, the sea in front, and his own native Renfrewshire hills in the blue distance, he became almost a boy again as he told his reminiscences of old times and watched the sports of children among the gray boulders. Ripe in honours as in years, it seemed as if he had come back to his early northern air to drink it once more, and review his past before he should quit us for ever. He would saunter for hours in the quiet glen, with no companion but his own thoughts and the sights and sounds of Nature, which were an ever-gushing fountain of pleasure to him. Cherished is every memory of him, but most of all those parting days spent with him at the foot of the mountains and by the shore of the restless sea.

A. G.

ROBERT A. C. GODWIN-AUSTEN, F.R.S.

IN many respects Mr. Godwin-Austen stood out apart from his fellow-geologists in this country. He wrote comparatively little, but what he did write was always weighty and full of suggestiveness. Instead of loading the literature of science with a pile of little papers, each containing some trifling addition or supposed addition to the sum of knowledge, or some criticism well- or ill-founded of the work of others, he allowed his ideas to mature, and published them from time to time in luminous essays which many years afterwards may be read over again with profit as well as pleasure. He began to write about half a century ago, his earliest papers being devoted to the geological features of Devonshire, of which, at that time, very little was known. By degrees he extended the area of his observations eastwards into the south-eastern counties. His essays "On the Valley of the English Channel" (1850), and "On the Superficial Accumulations of the Coasts of the English Channel, and the changes which they indicate" (1851), were among the most thoughtful contributions that had ever been made to the elucidation of the existing outlines of sea and land. This department of inquiry was one that peculiarly fascinated him. Hence, when his friend Edward Forbes died and left his "Natural History of the European Seas" only half completed, he himself chivalrously finished it, and supplied some chapters which only an accomplished and far-sighted geologist could have written. His various papers on drift-gravels, on boulders in the Chalk, and other superficial phenomena, are all marked by the same grasp and breadth of treatment.

But perhaps the paper which has chiefly contributed to give Mr. Godwin-Austen his ascendency among English geologists and to make his name known beyond geological circles is his now well-known essay "On the Possible Extension of the Coal-Measures beneath the South-Eastern Part of England" (1855). In this remarkable memoir he brings to bear his detailed knowledge of the rocks of the south-west of England, the north of France, and the adjoining tracts of Belgium. He marshals all his facts in such a way as to enable us, as it were, to strip off the thick cover of Mesozoic formations and trace the deep-seated connection of the Palæozoic area of Southern England and the Continent. At the time when he wrote, nothing was actually known of the subject, but he predicted that a submerged Palæozoic ridge would be found extending from the south-west of England into France and Belgium. The results of the deep borings of recent years have fully verified this prediction.

Mr. Godwin-Austen, in his prime, was a frequent speaker at the meetings of the Geological Society, where his keen penetrative criticism and caustic sarcasm formed a prominent and valuable feature in the debates. Some of his most suggestive and pregnant views of geological questions were thrown off in the course of these debates, and were never otherwise published by him. He never courted publicity, but rather shrank from it as an incumbrance under which he would not willingly be fettered. For many years past he has lived as a retired country squire at his beautiful residence near Guildford, taking full interest in the progress of science, and glad to see his fellow-workers in geology under his roof, but seldom venturing into the turmoil of town and the disputatious atmosphere of learned societies. It is some consolation to geologists, who mourn the quenching of one of their luminaries, that his place is taken by a son who, by scientific labours in India and in this country, has proved himself a worthy successor.

CHARLES CLOUSTON

THE Rev. Chas. Clouston, LL.D., of Sandwick Manse, near Stromness, who died on the 10th ult. at the very advanced age of eighty-four years, was a man who

deserves more than a passing notice in our columns. To name one only of his many claims to scientific recognition, he commenced meteorological observations in Stromness in the year 1822, and continued them, either there or in the adjacent parish of Sandwick, to within a fortnight of his death in 1884.

He belonged to the old Norse stock in Orkney, coming from the township of Clouston in Stennis. Two families of this name now live in the township, having succeeded to their farms, by direct descent, for over 400 years. He studied in Edinburgh University, and had at first been destined for the medical profession. He became a Licentiate of the R.C.S. in Edinburgh in 1819, and at his death was probably the father of the College. When in 1826 he entered on his duties as assistant and successor to his father, in the combined parishes of Stromness and Sandwick, there was no medical man in the latter place. For nearly fifty years he acted as the local doctor, in addition to his clerical duties, giving advice and medicines *gratis*. His father had been minister of Stromness for over sixty years, so that father and son had kept up a continuous ministry for 120 years. He received the degree of LL.D. from the University of St. Andrew's many years ago.

In the year 1862 Dr. Clouston's reputation as a careful meteorological observer was so well established that Admiral FitzRoy intrusted to his charge an anemometer, which has been kept in constant operation for the space of twenty-two years. The original instrument was replaced by a new one in 1869. A discussion of the results of the first five years' records (1863-68) appeared in the *Quarterly Weather Report* for 1871. In addition to his regular observations and deductions therefrom, which he occasionally published, he wrote an essay, "An Explanation of the Popular Weather Prognostics of Scotland, on Scientific Principles," which gained the prize allotted by the Marquis of Tweeddale in 1867. His observations for the last thirty years, at least, have been regularly published by the Registrar-General for Scotland.

Dr. Clouston was not only a meteorologist, but an ardent follower of every branch of science which came in his way. In his "Guide to the Orkney Islands," a reprint of a portion of "Anderson's Guide," he modestly says, "Taking the Orkney Flora, as Dr. Neill left it, to include 462 specimens, and adding our own contribution of 156, it now contains 618 species." In archæology he took an active part in the exploration of Maes How, and the House of Skaill, both of them within a walk of his home.

Dr. Clouston leaves a widow, two sons, and two daughters, but more than one member of his family passed away before him. In conclusion, we can only say that a visit to Sandwick was ever a rare treat; the warm hospitality of the manse, and the interest of the conversation carried on round the table, could not fail to leave an impression which will not easily wear away.

ON THE AUTUMNAL TINTS OF FOLIAGE

AFTER the fine display of autumnal tints which we have lately seen it may, I trust, be of interest to some of the readers of NATURE if I give an account of the chief conclusions to which I have been led by carefully studying the subject for many years.

As a general rule the colour of leaves in their normal condition depends on a variable mixture of two perfectly distinct green pigments and of at least four perfectly distinct yellow substances. The development of the autumnal tints is mainly due to the disappearance or change of the green constituents and to the production of highly-coloured pigments by the oxidisation of previously existing very pale or colourless substances. It is, in fact, due to a more or less complete loss of the vitality which previously counteracted these chemical changes, and the order in which the tints are developed can be easily explained, if we assume that the death of the leaves takes place somewhat gradually. The first visible effect of the reduced vitality is the change in the green pigments. In many cases they appear to be converted into colourless products, since the resulting bright yellow leaves differ from the normal green in the absence of chlorophyll, and merely contain the usual previously-existing yellow pigments. At the same time it is quite possible that an increased quantity of some of these yellow substances may be formed as a product during the change, but of this there is no positive proof. In the case of such trees as the alder, the chlorophyll does not thus disappear, but is changed by the presence of a weak acid into a very stable brownish-green product which resists further change. The production of bright yellows or dull browns thus clearly depends on whether the chlorophyll does or does not disappear before being modified by the action of acids, as may be verified experimentally by exposing suitable solutions to sunlight. It is, however, very clear that the manner in which it changes depends very much on the conditions of the case. Thus, if chlorophyll is exposed to sunlight dissolved in bisulphide of carbon, a reddish-coloured product is formed, and though this differs very greatly from the red pigment met with in many autumnal leaves, it seems probable that under some conditions the chlorophyll in leaves is changed by the action of light into a red substance. By taking green sorrel leaves and keeping them somewhat fresh by sticking the stalks into moist ground, I found that those exposed to the sun with the under side upwards turned to a bright red, whereas those kept in the shade did not develop any fine colouring. We may often see that partially broken leaves or twigs undergo this change when all other parts of the tree remain green, and this and various other facts lead me to conclude that the change of chlorophyll into a red product depends on a certain amount of reduced vitality as well as on little-understood conditions varying in different kinds of plants. Though I fully admit that there are some facts not easy to understand, yet on the whole it seems to me that these principles fairly well explain why certain leaves turn red in autumn. Slight frosts reduce their vitality in such a manner that the chlorophyll is changed by the action of the light into a red product. Thus, according to the character of the season and the nature of the plants, the first effect of the reduced vitality in the leaves is that the chlorophyll is removed so as to show their normal yellow colour, or is changed into a red pigment, or is altered into a comparatively stable dull brown green product. These are the three extreme changes, but in many cases intermediate mixed results give rise to such less perfect and well-marked tints as dirty yellows and reds.

The next series of changes is best studied in the case of those leaves which in the first instance turn to a bright yellow, and it appears to me that they depend mainly, if not entirely, on the production of deeply-coloured pigments by the oxidisation of tannic acid and other more or less colourless substances. The difference in the resulting tint seems to depend on the nature of these substances. Thus, for example, the tannic acid in the yellow oak leaves changes into a brown substance, whereas the quino-tannic acid in yellow beech leaves changes into the fine orange-brown colour which makes those trees so ornamental in autumn. On the contrary, the bright yellow poplar leaves rapidly pass to a dark dirty brown by the alteration of another constituent. Other kinds of leaves give rise to tints of an intermediate and less well-marked character. In many cases it is almost impossible to draw the line between the colour of this stage in the change and the final dark and dirty browns of dead and decaying leaves. For fine effect very much depends upon the production of each special tint in a fairly pure state, so as to show bright yellows, reds, and browns. This seems to be influenced by the character of the weather.

It is also, of course, important that the half-dead leaves should hang long on the trees, so as to develop their full colouring before being blown off by the wind.

Taking thus all the facts into consideration, it appears clear that all the bright and beautiful tints of autumn are merely the earliest stages of decomposition, and are due to the more or less considerable triumph of chemical forces over the weakened or destroyed vitality of the living plant. One cannot but feel that this is a very unpoetical way in which to regard the magnificent tints of a fine autumnal landscape, but it is no less true than that the coloured clouds of evening mark the departing day.

H. C. SORBY

A TORNADO PHOTOGRAPHED

I SEND you to-day a photograph of a genuine Dakotah cyclone, or, rather, tornado, which was taken by F. N. Robinson, Howard, Miner County, D.T., August 28, 1884. The storm passed twenty-two miles west of the city. It was first noticed at 4 o'clock p.m., moving in a south-easterly direction, remaining in sight over two hours; killing several people, and destroying all property in its course. I believe it to be unique as a portrait of this class of storms, and I have thought you might care to reproduce it for NATURE.

EDWARD S. HOLDEN

Washburn Observatory, University of Wisconsin, Madison, November 14

METEOROLOGY OF MAGDEBURG[1]

THE second report, just published, of the Meteorological Observatory of Magdeburg presents some special features of interest. The observations with the instruments in more general use are given in very convenient forms in detail and abstract.

Magdeburg was one of the first observatories to adopt the barograph of Dr. Sprung, which is certainly one of the best barographs we possess. After the purchase-cost of 40*l.*, the annual outlay in working it and preparing its curves of continuous registration for the lithographer is trifling. The curves are also of high value as accurate representations of the variations of atmospheric pressure. The whole of these curves are reproduced by Dr. Assmann in an elaborate series of lithographs, on which the inch of pressure is on a scale of four inches, and the twenty-four hours of the day extend over five inches and a half. By this large scale the minuter changes of pressure are represented with great distinctness, and their relations to changes of wind, cloud, and other weather conditions can be more clearly seen. Dr. Assmann draws attention to five of the small changes from August 27 to 30 as disturbances due to the Krakatoa eruption.

The hourly values have been taken from these curves, and the means for the months calculated and added to the report. From these means and those of the previous year, a first approximation to the diurnal oscillation of the barometer for this part of Europe is obtained. The result is peculiarly interesting from the transitions it shows in the hourly variations of the summer pressure as compared on the one hand with the variations which occur at the stations of the German Seewarte on the North and Baltic Seas, and on the other with those which occur at places more in the interior of the Continent. Unfortunately for the prosecution of several inquiries raised by these differences, hourly hygrometric observations are not available from any of these first-class meteorological observatories.

Another interesting feature are the twelve lithographs which represent the continuous registrations of the sunshine recorder, on the scale of 0·4 inch for each hour These lines, which show the sunshine and inferentially the state of the sky in respect of cloud, give valuable information regarding certain hygrometric states of the atmosphere. Hence, with the aid of these and the barometric curves, the influence on the diurnal curve of

[1] "Jahrbuch der Meteorologischen Beobachtungen der Wetterwerte der Magdeburgischen Zeitung." Herausgegeben von Dr. R. Assmann. Jahrgang II. 1883. (Magdeburg, 1884).

pressure of such widely-contrasted states of weather as continuous strong sunshine and continuous cloud may be investigated.

The direction and force of the wind for each hour of the year is given in full. As regards force, the results show for each month a minimum during the night, or, rather, early morning, and a maximum at noon or shortly thereafter. The extremes of difference occurred in December and June, the maximum being only one-fifth greater than the minimum in December, whereas in June the wind blew with more than double the velocity during the hours about noon than it did from 2 to 4 a.m. It may be remarked here that also in June the sunshine attained to the annual maximum. The relations of the hourly variations of wind direction and force to some of the more decided disturbances of the barometric curves are interesting and striking; and still more striking and important would have been the comparisons of the minute disturbances in the barometric curve with similar disturbances shown by continuous registrations of direction and velocity of wind.

The rest of the report is taken up with observations, either once or thrice a day, of the temperature of the soil at depths, in metres, of 5, 3, 1, 0·15, 0·05, and 0·00; daily observations with maximum and minimum thermometers under a thin covering of earth, exposed on bare soil, and immediately over short grass; daily observations with five maximum and five minimum thermometers at heights, in metres, above the ground, of 0·05, 0·20, 0·40, 0·60, 0·80, and 1·00; observations with the solar radiation thermometer at a height of 102 feet, and on the evaporation,—all indicative of the spirit of activity and research which happily characterises this Observatory.

ON A HYDRIFORM PHASE OF "LIMNOCODIUM SOWERBII"

It is now four years and a half since Mr. Sowerby first discovered the fresh-water jelly-fish in the tank at Regent's Park, and since that time no definite advance has been made towards clearing up the mystery of their life-history.

Prof. Lankester has continued to make observations and experiments of various kinds, in which I have assisted him, but we have hitherto had no opportunity of examining the tank after the withdrawal of the water. This year, however, Prof. Lankester arranged with Mr. Sowerby that we should be present at that operation. This took place on Thursday last. We collected a large quantity of the sediment and portions of the roots of various plants, and Prof. Lankester kindly placed the whole of this material in my hands for further investigation. I soon discovered upon some of the *Pontederia* roots numerous specimens of a minute organism which proved to be hydroid in nature, and evidently a phase in the life-history of *Limnocodium*.

Further particulars, including an account of its remarkable structure, and the possible theories as to its connection with the Medusiform person, I reserve till next week, when Prof. Lankester has kindly offered to communicate them for me to the Royal Society.

I may add that Mr. Sowerby has kindly made arrangements at the Botanic Gardens for keeping the *Pontederia* roots in water in the warm tank during the winter, and that, with Mr. Thiselton Dyer's kind permission, I have placed one of the roots in the Royal Gardens at Kew.

ALFRED GIBBS BOURNE

NOTES

THE Lords of the Committee of Council on Education have received information, through Her Majesty's Principal Secretary of State for Foreign Affairs, that Her Majesty's Consul at Antwerp has been appointed British Commissioner for the International Exhibition which is to be held at Antwerp next year, and that Mr. P. L. Simmonds has been appointed by the Executive Council of the Exhibition at Antwerp their Agent-General for Great Britain and Ireland. The Exhibition in question is a national undertaking under the immediate patronage of His Majesty the King of the Belgians and of the Belgian Government. The President of the Exhibition is H.R.H. the Count of Flanders, and the Vice-President the Minister of Agriculture, Industry, and Commerce. The office of the Agent-General is at 35, Queen Victoria Street, and communications from intending exhibitors should be addressed to him there.

A REMARK was made at the Royal Society dinner on Monday touching the rapidly increasing number of awards of Royal medals not only to Cambridge men, but to men at Cambridge. In connection with it we may refer our readers to an appreciative article in Tuesday's *Times* on Natural Science at that University, in which the immense progress made during the last twenty years is well brought out. The results which may follow from the growth of a Medical School, and of Girton and Newnham, are indicated. The article concludes with the statement that the new studies, for good or ill, have taken root firmly. "They have already exercised a strong depolarising effect upon the cherished traditions and practices of the older studies. Everything is looked at in a new light, from a scientific point of view; and nothing which cannot stand the scientific test is allowed to pass unchallenged. The outcome of all this can be but dimly foreseen."

AT the annual meeting of the Fellows of the Royal Society of Edinburgh, held on Monday, the 24th ult., the following were elected office-bearers for next year:—President: Thomas Stevenson, M.I.C.E.; Vice-Presidents: Rev. W. Lindsay Alexander, D.D., Robert Gray, A. Forbes Irvine of Drum, Edward Sang, LL.D., David Milne Home, John Murray; General Secretary: Prof. Tait; Secretaries to Ordinary Meetings: Prof. Turner, Prof. Crum Brown; Treasurer: Adam Gillies Smith, C.A.; Curator of Library and Museum: Alexander Buchan, M.A.; Councillors: Prof. Cossar Ewart, Prof. James Geikie, Rev. Dr. W. Robertson Smith, Stair Agnew, Prof. Douglas Maclagan, M.D., Hon. Lord Maclaren, Rev. Prof. Flint, D.D., Prof. T. R. Fraser, M.D., Prof. Chiene, J. Y. Buchanan, Prof. Chrystal, Prof. Dickson.

THE University of Edinburgh has just suffered a severe loss by the sudden death of its Principal, Sir Alexander Grant. Many men of science in all parts of the world, who attended the Tercentenary Celebration last April, will remember the prominent and successful part played by the Principal in that remarkable gathering. Full of fresh zeal from this recent triumph of the University, he only a month ago opened the winter session by giving an address to the students, and seemed likely for many years to keep his post and witness a still further increase of that unexampled prosperity which the University has enjoyed under his rule. But this was not to be. He was struck down by an apoplectic attack on Sunday last in his fifty-eighth year.

M. COCHERY, the French Minister of Postal Telegraphy, has ordered the employment of the pneumatic system, which has now been completed in Paris, for the conveyance of ordinary letters to the several railway stations after the closing hours of the different post-offices, the charge being fixed at three deniers for each letter. This is said to be a step preliminary to the carriage of letters, instead of postal cards, by the tubes at an accelerated rate.

WE have received from Messrs. De La Rue and Co. their Diaries—pocket and otherwise—for the ensuing year, and also a charming collection of Christmas cards. The former are as beautifully finished and as full of scientific information and data

as usual. Some of the new series of Christmas and New Year's cards have also a scientific side to them, as they refer to flowers and birds, form and colour being carefully studied, and perhaps even more carefully given than they are in many books of botany and natural history. The series which gives us the story of a fox hunt by monkeys on dogs contains some very masterly drawing.

MR. NEWALL has forwarded to us a sketch of the face of one of several watches which he designed and had made some years ago by Mr. D. Glasgow, of Myddleton Square, President of the Horological Institute. The "hours" are replaced by a large round dot, which is easily seen even on a dark night in the Observatory, and there is no need for figures or a double row of them to count up to 24 o'clock, as has been suggested.

WE have received vol. xx. of the *Transactions* of the Royal Society of Victoria, being a record of the work of the Society for last year. The longest paper in the number is one by Mr. Howitt, on the rocks of Noyang; two communications by Messrs. Blunt and Jamieson deal with the influence of light on bacteria, while Mr. Ralph discusses the occurrence of bacteria (bacilli) in living plants. In a paper on modern fireproof and watertight building materials, Mr. Behrendt refers specially to Trägerwellblech ("bearing corrugated iron plates") and asphalte. Mr. Ellery, the President of the Society, communicates notes on the recent red sunsets, which he attributes to the prevalence of vapour in the higher regions of the atmosphere; on the rainfall map recently issued by the Government of Victoria; and on the early history of telegraphy, the invention of which he attributes to Mr. Edward Davy, at one time of the Assay Office in Melbourne. Mr. MacGillivray gives the fifth and sixth instalments of his lists and descriptions of new or little-known Polyzoa. The remaining papers printed in the volume (although many more were read before the Society) are:—On the caves perforating marble deposits, Limestone Creek, by Mr. Stirling; incandescent lamps for surgical and microscopical purposes, by Mr. Joseph; electric lighting for mines, by the same author; notes on the dressing of tin ore, by Mr. Newberry; and notes on hydrology, by Mr. Steane.

A PROJECT which, if executed, would render the Paris Exhibition of 1889 for ever memorable, has been published by M. Eiffel, the French engineer, and is described in *La Nature*. It is to erect in the grounds of the Exhibition an iron tower 300 metres in height, that is, twice as high as the Great Pyramid, and more than twice the height of the Strasburg Cathedral; 160 metres he considers as the limit of height possible in a structure of which stone is the principal material, and hence iron is proposed. The base of the tower is of pyramidal shape, and is to be 70 metres high, and the superficial area at this height will be 5000 square metres; above this there are to be three other stages, or stories, in which will be rooms which it is proposed to use for various purposes, scientific and other. The towers of Notre Dame will be mere pygmies beside this colossal structure, and will not reach to its first floor. The projector points out that, in addition to its monumental character, the structure will be useful for strategical purposes in war time, on account of the vast range of view, for meteorological and astronomical observations, for at such a height the clearness of the air and the absence of fogs would render observations possible which cannot be made on the ground. The tower might also be used for the electric light. The whole exhibition and the surrounding neighbourhood might thus be lighted from a central point. Many scientific problems may, it is suggested, be investigated from the tower, such as the resistance of the air to different weights, certain laws of elasticity, the study of the compression of gas or vapours, of the oscillation of the pendulum. In shape it is to resemble an enormous lighthouse, gradually tapering from a wide base to the summit.

WE learn from *Science* that the Norwegian bark *Loveid*, recently arrived in Philadelphia, reports a very peculiar squall experienced October 18, in lat. 39° 49′ N., long. 69° 5′ W. During fine, clear weather, with a light breeze from the northwest, heavy banks of clouds of most threatening aspect suddenly appeared, driving in every direction. Almost immediately a heavy squall of wind and rain struck the vessel, the wind shifting quickly all around the compass. In the midst of this disturbance, which lasted about an hour, a single peal of thunder was heard, and simultaneously a bolt of lightning struck the foreroyal mast-head, and ran down the mast to the royal yard, which was almost destroyed. The lightning, which looked like a ball of fire, then ran out on the horn of the cross-trees, and "burst" with a loud report, scattering sparks all over the vessel. The barometer fell suddenly from 30 to 28·60, and then rose as rapidly, the weather becoming pleasant immediately afterwards. This is rather a peculiar squall, considering the locality and the season.

THE New York *Financial and Mining News* contains an account of the extraordinary effect of an explosion of a large quantity of nitro-glycerine in what appeared to be an extinct oil-well in the Pennsylvanian oil-fields. A careful examination of the soil in the shaft failed to reveal any trace of oil or gas, and at length, as a last resource, it was decided to try the effect of an explosion of a shell containing fifty quarts of this explosive. First a column of water rose eight or ten feet and then fell back; a few moments later the burnt glycerine, mud, and sand rushed up the derrick in a black stream, the blackness gradually changing to yellow. Then, with a roar, the gas burst forth in a cloud which for a moment hid the derrick from sight, and as it cleared away revealed a solid golden column half a foot in diameter shooting from the derrick floor eighty feet through the air, till it broke into fragments on the crown pulley and fell in showers of golden rain for many yards around. This column of oil continued for an hour rushing in a torrent into the air. The branches of the trees around were like huge yellow plumes, and a large stream ran down the hill to a road, where it nearly filled the space beneath a small bridge. In two hours the neighbouring flats were covered with a flood of oil, and the hillside looked as if a freshet had passed over it, while heavy clouds of gas hung low over the woods. Dams were built across the stream in order that the production might be calculated, but they were borne away almost as soon as erected. The people living near the flats fled to the hills; fires had to be extinguished in the district to prevent a conflagration. The outflow was estimated at 8000 barrels in twenty-four hours. Ultimately the stream was diverted into the banks, after much labour and some danger. It was noticed that all the wells in the neighbourhood declined as soon as the outflow here mentioned commenced, the gauges in some of them showing at the end of three days a fall to half their previous depth.

M. JAMIN, Perpetual Secretary of the Paris Academy of Sciences, has been elected a member of the Société française de Navigation aérienne. He will take his seat next Thursday, the 11th inst., and is to deliver a speech on the occasion. He is at present engaged in writing an exhaustive article on aërial direction, which will very shortly appear in the *Revue des deux Mondes*.

ON Saturday night Mr. H. M. Stanley, on leaving Berlin after attending the West African Conference, was entertained at a banquet by the Central Society for Commercial Geography. A peculiar feature of the banquet was an ethnological study in the shape of a group of mummers representing some races of Africa, presumably those of the Cameroon and Angra Pequena regions.

AN earthquake was felt on Sunday and Monday, November 23 and 24, near Briançon, in the valley of Queyras on the banks

of the Guil, a torrent discharging into the Durance, in the Department of the Hautes Alpes. Three days afterwards, on Thursday the 27th, a severe shock was felt at Grenoble, about 100 km. west-south-west from the Queyras valley. It lasted thirty seconds, passing in a direction from west to east. All the houses were shaken, but no injury is reported beyond the fright sustained by the inhabitants. The same night, almost at the same hour, six shocks were felt at Lyons, moving in the same direction; and commotions of a similar kind are announced from Turin and the sea-coast of Provence, at Cannes and Nice in particular.

WE regret to hear that M. Duprez de Lonce, the celebrated naval engineer and Member of the French Academy of Sciences, is dangerously ill, and that his life is almost despaired of.

WE regret to announce the death, at Paris, at the age of seventy-four, of M. Quet, a distinguished French mathematician, well known for his works in connection with capillarity, electricity, &c., most of which have appeared in the *Comptes Rendus* of the Paris Academy of Sciences.

M. W. DE FONVIELLE has published a pamphlet on "L'Aérostat dirigeable de Meudon," in which he endeavours to show that the reports current in the French Academy respecting the experiments in question are exaggerated, though at the same time he seeks to do justice to his distinguished countryman, who has twice succeeded in proving that by means of electricity the power of resistance may be imparted to balloons. He concludes by recommending that, the electric fluids having done their part, *la parole est à le vapeur.*

INTERESTING researches with so-called Paradise fish (*Macropus venustus*) were made at the Berlin Aquarium recently. The fish is a native of China, its body, only a few centimetres long, is of the brightest hues, and its bluish-green fins are so enormously large that the fish seems almost to succumb under their weight. It is easily kept, and breeds frequently in captivity; the temperature of the water it is kept in must, however, not be allowed to sink below 20° C.

ONE result of the recent expedition sent from Quetta under Sir Oriel Tanner to punish the inhabitants of the Zhob Valley is stated in a telegram from Calcutta to be a complete survey of the whole of that valley. It has been ascertained that the best road from the Gomul Pass to Candahar does not lie, as had been supposed, through the Zhob Valley, but through the valley of the Khwandar, and that the route is practicable for a large army.

DR. OTTO FINSCH left Sydney on September 10 by the steamer *Samoa*, *en route* for the Phœnix and Union Islands, where he intends staying for some time and making extensive ethnographical collections.

THE *Boletin* of the National Academy of Sciences in Cordova, Argentine Republic (Buenos Ayres, 1884), has a very long paper by Señor Ameghino on his geological and palæontological investigations in the province of Buenos Ayres. The only other paper is by Herr Doering, and deals with the sinking of artesian wells in the Argentine Republic.

THE Rev. Henry H. Higgins publishes in a separate form a paper on "Museums of Natural History," read before the Literary and Philosophical Society of Liverpool. After an experience of over a quarter of a century, during which he passed several times every week through museum rooms, the author calculates that out of a thousand visitors to the Liverpool Museum, ten to twenty were students, 780 interested observers, and 200 loungers.

MR. CHARLES C. SHERRINGTON, B.A. of Caius College, Cambridge, has been elected to the vacant George Henry Lewes Studentship.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mr. W. J. Bennett; a Rhesus Monkey (*Macacus rhesus*) from India, presented by Mr. Samuel Levi; an Ocelot (*Felis pardalis*) from America, presented by Mr. H. B. Whitmarsh; two King Parrakeets (*Aprosmictus scapulatus*) from New South Wales, presented by Mr. E. Meek; a Cheer Pheasant (*Phasianus wallichii* ♀) from North India, presented by Mr. E. Buck; a Pig-tailed Monkey (*Macacus nemestrinus* ♂) from Java, deposited; a Rufous-necked Weaver Bird (*Hyphantornis textor*) from West Africa, received in exchange; four Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

THE ROYAL SOCIETY ANNIVERSARY

THIS meeting took place on Monday last, the time-honoured date—St. Andrew's Day—falling on Sunday. In the regretted absence of the President, Prof. Huxley, who, the Fellows were rejoiced to learn, is rapidly recovering his health from his sojourn in Italy, the Treasurer, Mr. John Evans, occupied the chair and read the following address:—

The absence of our President from his post to-day must of necessity cast a certain amount of gloom over the proceedings at this our anniversary meeting, and, personally, I feel additional regret that it devolves upon me, as your Senior Vice-President and Treasurer, to be the unworthy occupant of the chair on the present occasion. My regret at the absence of the President is, however, in one respect tempered by a strong hope, in which I am sure that you will all fervently join, that the timely retirement from arduous work which has been enforced upon him by his medical advisers may produce those beneficial results which we all so cordially desire, and that we may ere long again see among us our accomplished and valued President in renewed health and strength.

I must, however, turn from the expression of our hopes for the future, to that of our regrets for the past, and for a short time dwell upon the mournful list of vacancies which the ever-active hand of death has caused in our ranks during the past twelve months. In one respect only can a topic of consolation be found in this list. It is that in extent it is less than that of last year, the total number of our deceased Fellows being only eighteen on the home list and two on the foreign list, while those numbers were twenty-one and two respectively at our last anniversary.

Both the foreign members whose loss we have on the present occasion to deplore were men of the highest distinction in chemical science. Both were residents at Paris, and both had Chairs in the French Academy, of which the one had been since 1868 one of the permanent secretaries. I cannot dwell upon the discoveries and the remarkable career of M. Jean Baptiste André Dumas, whose energy and perspicuity, even when past the limit of fourscore years, all those who of late have had the opportunity of being present at a meeting of the French Academy must have found reason to admire. An appreciative memoir of him by one of our own Fellows, who of all men living is perhaps the best qualified to judge of the value of his labours—Prof. Hofman—written while Dumas was still among us, will be found in the pages of our own *Proceedings* (vol. xxxviii. x.), and those of NATURE (vol. xxi. February 6, 1880). It will give some slight idea of the extent of time over which the labours of M. Dumas have extended if I mention that, so long ago as in 1843, he received the Copley Medal at our hands, at a time when his chemical and physiological researches had already extended over a period of twenty-two years. M. Dumas died at Cannes on April 11 last, and among the most touching of the speeches at his obsequies was that of M. Würtz, whose own decease took place on the 12th of the following month.

Although nearly twenty years younger than M. Dumas, M. Karl Adolph Würtz had for a long time been one of the most distinguished leaders of modern chemical science, especially in the department of organic chemistry, and his merits were recognised by this Society in 1864, when he was elected one of our foreign members, and again in 1881, when the Copley Medal was awarded to him.

Among our English Fellows was a contemporary of Würtz, who, like him, had been a pupil of the illustrious Liebig, but whose bent was more on the practical than on the theoretical

side of chemistry—I mean Dr. Angus Smith, whose official labours in favour of pure air and pure water combined both tact and zeal, and were productive of highly beneficial results.

One other chemist has been taken from among us, Mr. Henry Watts, the well-known editor of the "Dictionary of Chemistry," and of more than one issue of "Fownes's Manual."

Our other losses extend over various departments of science. In botany our ranks are thinned by the death of Dr. John Hutton Balfour, formerly Professor of Botany at Glasgow and the Emeritus Professor of that Chair in the University of Edinburgh; and of the veteran Mr. George Bentham, who had nearly completed his eighty-fourth year. During his long and varied experiences of life, botany was his constant pursuit and study; and some thirty years ago, after presenting his fine collections and library to the Royal Gardens at Kew, he devoted himself to labouring there on the Floras of Hong Kong and Australia, and in conjunction with Sir Joseph Hooker, on the "Genera Plantarum," until his health gave way in the spring of last year. The exceptional value of his botanical work was recognised by this Society in 1859, when a Royal Medal was awarded to him, and his regard for the Society has been testified by his making a bequest of 1000*l*. to our Scientific Relief Fund.

Among mathematicians we have lost Dr. Isaac Todhunter, whose educational treatises have for many years been recognised as standard works, and whose elaborate histories of different branches of mathematical science have earned for him a high reputation; and Mr. Charles W. Merrifield, who, in addition to achieving distinction by his educational works on arithmetic and mathematics, did much in the direction of the practical application of science, and at the Royal School of Naval Architecture and Marine Engineering successfully laboured in improving the stability and the sea-going powers of the British Navy.

Another distinguished mathematician whom we have within the last few weeks had the misfortune to lose, was the Rev. Richard Townsend, Professor of Natural Philosophy in the University of Dublin, whose labours in the more abstruse fields of geometrical speculation extended over a period of nearly forty years. Mr. James Rennie was also a votary of mathematical research.

Among practical men of science, the veteran Mr. Charles Manby, who for forty-five years had been Secretary or Honorary Secretary of the Institution of Civil Engineers, will deservedly take a high place.

The anatomical and physiological labours of Prof. Allen Thomson had extended over the longer term of fifty-four years, and few possessed the power of clearer exposition than he, while for acts of personal kindness there must be many besides myself who owe him a deep debt of gratitude.

Among others connected with the medical profession we miss the distinguished surgeon Mr. Cæsar Hawkins, Dr. Alexander Tweedie, and Sir Erasmus Wilson, whose name will long survive, not only in connection with dermatology and the Chair of Pathological Anatomy at Aberdeen, but with the Egyptian obelisk, known as Cleopatra's Needle, the presence of which in London is entirely due to his liberality.

In Mr. R. A. C. Godwin-Austen we have lost one who for nearly fifty years had ranked among the foremost of English geologists. His manifold observations will be recorded elsewhere, but as an instance of his critical powers, I may mention his now classical paper on the possible extension of the Coal Measures beneath the south-eastern part of England, read in 1855, his speculations in which as to the western extension of the axis of Artois, all recent deep borings within the Thames Basin have so fully substantiated.

In Dr. Wright we have lost an accomplished palæontologist whose knowledge of the fossil Echinodermata and Ammonitidæ was almost unrivalled.

The Duke of Buccleuch had for fifty years been one of our Fellows, and in 1867 occupied the position of President of the British Association; while Sir Bartle Frere, although an ethnologist and geographer, will probably be better known as an able and energetic public servant and administrator than as a man of science.

In common with the nation at large, we have to deplore the untimely and unexpected decease of another distinguished statesman, the late Postmaster-General, Mr. Fawcett. A man of rare mental powers, the effect upon him of the greatest of all physical deprivations, the loss of sight, was only to make him rise superior to his misfortune. As a student of political economy he attained a high reputation, and he turned his mastery of the subject to good account when he entered into the sphere of public life towards which his natural aspirations led him. His singleness and honesty of purpose, the inborn justice of his well-balanced mind, his devotion to the public good, and his invariable courtesy, endeared him alike to political friends and opponents; while to those who were brought into more immediate contact with him, his truly sympathetic nature, and the marvellous memory which preserved even minute details of former conversations, gave a charm to his intercourse which none who enjoyed it will ever forget.

As I have already observed, our losses on the home list, including one resignation of Fellowship and one removal from our list, are less than in many former years, being altogether 21 in number; we have, on the other hand, elected 16 Fellows, including one Privy Councillor. It would, however, appear that our numbers are gradually attaining to something like a state of equilibrium, and that if our elections continue to be limited as at present, the roll of the Society will remain at its present standard of about 470 Fellows. Looking at the recognised longevity of scientific men and the age at which many now achieve the distinction of being elected into the Society, it seems to me not improbable that our numbers will ere long show a tendency to increase rather than to diminish.

Of the *Philosophical Transactions* three parts, and of the *Proceedings* eleven numbers, have been published; while the number of papers received during the past year was 100, as compared with 103 in the previous year. Of these the most numerous have been in the departments of electricity and magnetism, though physics and mathematics, chemistry, mineralogy, anatomy, and physiology, botany, and morphology have all had their share.

It is hardly within my province to select any papers that we have published as being the most worthy of mention. The mere fact that they have appeared in the *Philosophical Transactions* is a sufficient voucher for their value. I may, however, call attention to the report of Captain Abney and Dr. Schuster, our Bakerian Lecturer for the present year, on the total solar eclipse of May 17, 1882, which is the outcome of an expedition towards which a grant of 350*l*. was made from our Donation Fund. Some of the results were mentioned by Mr. Spottiswoode in his Presidential Address of 1882, but the value of the details with regard to the corona, and the success which attended the efforts of the photographers, can only be estimated from an examination of the paper itself. The detailed results obtained by the photographers who accompanied the American expedition to Caroline Island in the South Pacific in order to observe the solar eclipse of May 5, 1883, have not yet been brought before the Society.

In respect to biological studies, our record of the past year, though it does not contain the announcement of any very startling results, gives evidence of fruitful activity along various lines of research.

In Botany, Mr. Gardiner has continued his observations on the important subject of the continuity of protoplasm in vegetable cells, which was referred to in the President's Address of last year; he has also brought forward some interesting results derived from an examination of the changes in the gland-cells of Dionæa, which serve still further to illustrate the identity of the fundamental physiological processes in plants and animals. Mr. Bower has dealt with the morphology of the leaf in certain plants, in a memoir both valuable in itself, and noteworthy because hitherto the study of abstract vegetable morphology has perhaps not obtained in this country the attention which it deserves, and which has been given to it in other countries, especially in Germany.

In Physiology two important papers have been presented on the difficult subject of the functions of the cerebral convolutions, one by Drs. Ferrier and Yeo, and the other by Prof. Schafer and Mr. Horsley. Both contain observations which demand careful consideration by all physiologists.

The results of the study of animal forms which is happily being carried on with great activity, I may say, all over the United Kingdom, are for various reasons principally recorded elsewhere than in the pages of the *Transactions* or *Proceedings* of this Society. Nevertheless, this subject has also been fairly represented at our meetings. Our distinguished and unwearied Fellow, Prof. W. Kitchen Parker, is still continuing his elaborate and valuable researches on the vertebrate skull; and during the past session the Society has had the pleasure of receiving several short papers, expounded in person by their author, from

a veteran in the study of animal morphology, whose first communication to the Society bears the date of 1832. I need hardly say I mean Sir Richard Owen.

A few words must be said with regard to the acquisitions made by our library and collections. Our gallery of portraits has, through the kind liberality of Dr. Wilson of Florence, received two important additions in the form of half-length original portraits of the distinguished mathematicians and philosophers, Leibnitz and Viviani, both of whom were Foreign Members of this Society. When we remember the warmth of feeling with which the rival claims of Newton and Leibnitz to the invention of Fluxions or the Differential Calculus were for many years discussed, and call to mind that the question occupied the attention of a Committee of this Society in 1712, which reported in favour of Newton's claims, we may rejoice that the heat of the controversy is long since over, and congratulate ourselves that the portraits of these rival intellectual giants now hang peacefully side by side on our walls. The portrait of Viviani, the great geometrician, the pupil of Galileo and the associate of Torricelli, and a contemporary of Newton and Leibnitz, finds also a fitting resting-place in our gallery.

Our portfolio of engraved and lithographic portraits of scientific men has been considerably augmented by liberal donations from the executors of our former President, the late Sir Edward Sabine, through Mr. R. H. Scott.

The Lalande Medal, which had been awarded by the French Academy to Sir Edward in 1826, and which, together with a Royal Gold Medal, was presented to the Scientific Relief Fund, was by the Council redeemed from the Fund, and will be preserved among our other medals as a memorial of one who for so long a period rendered important services to the Society. A bronze medal of our distinguished Fellow, Prof. Sylvester, has been presented to our collection by the Johns Hopkins University, at Baltimore.

The library itself has during the past year received by donations about 380 complete volumes, besides about 240 pamphlets, and more than 2400 parts of serials; 24 charts have also been presented to it.

With regard to our finances, I may venture to say, as your Treasurer, that I consider them to be in a satisfactory condition.

I must now turn to some of the subjects which, during the past year, have occupied the attention of the President and Council, and which in more than one instance have brought them into communication with Her Majesty's Government.

In July of last year a letter from the Treasury was received requesting our opinion as to the desirability of subsidising the Armagh Observatory, the income of which had been materially reduced, owing to recent legislation in Ireland. In reply to this an answer was sent pointing out the good work that had been done in the Observatory, and the exceptional character of the institution, and recommending it to the favourable consideration of the Government. Unfortunately, however, the loss of income applicable to the maintenance of an Observatory has not been made good, though the Treasury, "having regard to the advice of the Royal Society, and to the diminution in the income of the Observatory," has granted a sum of 2,000*l*. in aid of its funds, the annual income derived from which sum is to be applied by trustees to the maintenance and purchase of instruments and apparatus.

Another correspondence with the Treasury as to the bathymetrical survey of the lakes within the British Isles did not lead to any concession in favour of such a necessary complement to the National Ordnance Survey, though the omission in our maps of all details relating to the depth of our lakes and the contour of their beds, cannot be justified on practical, and much less on scientific grounds.

In May last the Astronomer-Royal brought under our notice the position of this country with respect to the International Bureau des Poids et Mesures, an institution established by what is commonly known as the Metric Convention; and it was resolved that in the opinion of the President and Council it was highly desirable that our country should take part in the International Commission of Weights and Measures, and contribute the sum which our adhesion would entail. A deputation was appointed to bring the subject under the notice of the Lords of the Treasury, and, after some correspondence, the Society was authorised to enter into informal negotiations with the officers of the Bureau, with the happy result that Great Britain was invited to join the Metric Convention, and through her Ambassador at Paris has, I believe, now given in her adhesion to it, and is entitled to all the privileges accorded by the Bureau. The appliances at the command of the Bureau for the verification not only of the standards of the metric system, but of other units of measure, far surpass in scientific accuracy anything that is at present available in this country, and we now enjoy the double advantage of being removed from the state of isolation in which for some years we have stood in regard to the other nations of Europe, and of now being affiliated to an establishment in which the verification of standards has been carried to the highest perfection. At the same time, it is distinctly understood that our adhesion to the Bureau in no way commits the Government of this country to any change of opinion favourable to the adoption of the metric system, but that our entire freedom to retain our own system of weights and measures is absolutely preserved. Whatever may be the advantages of the metric system from a scientific point of view, the question whether a scale of weights, money, and measures, which in its lowest denominations follows a duodecimal rather than a decimal system, is not better adapted for the convenience of daily life, is one that by many is regarded as fairly open to discussion.

Another event of both scientific and national importance has been the meeting of an International Conference on the subject of a Prime Meridian of Longitude. The desirability of a common starting-point from which to reckon degrees of longitude has long been felt among all civilised nations, especially those of a maritime character, and was discussed at some length during the Congress of the International Geodetic Association at Rome in October 1883. It was not, however, until the end of last year that invitations were issued by the United States Government for different countries to send representatives to an International Conference to be held in the city of Washington for the purpose of discussing, and, if possible, fixing upon a meridian proper to be employed as a common zero of longitude and standard of time-reckoning throughout the globe. The letter of invitation addressed to this country was referred to the President and Council of this Society, with a request to advise the Government whether it was advisable in the interests of science to accept the invitation. In reply, an opinion was expressed as to the high importance, both for the interests of science in general, and of our own country in particular, that our Government should be represented at the Conference, and the Treasury at once sanctioned the expense of sending two delegates to Washington. These were Sir Frederick Evans, the late Hydrographer to the Admiralty, and Prof. J. C. Adams. General Strachey, the Chairman of the Meteorological Committee, was also nominated to represent India, and Mr. Fleming to represent the Dominion of Canada. The delegates assembled at Washington in the month of October last, and proceeded to discuss the questions whether a single prime meridian for all countries should be adopted, and if so, through what point on the earth's surface should that meridian be drawn. After long discussion it was eventually resolved that the meridian of Greenwich should be generally adopted, twenty-two[1] of the nations voting in favour of this measure, and only one, San Domingo, against it. The representatives of France and Brazil abstained from voting. The proposal for the adoption of Greenwich was made by one of the representatives of the United States of America, and was fully discussed. Our own representatives ably supported the proposal, and another of our most distinguished Fellows, Sir William Thomson, who happened to be in America at the time, was courteously invited to attend the meetings of the Conference, and on the request of the President to express his opinions. The arguments adduced in favour of the adoption of Greenwich were such as must commend themselves to all unprejudiced minds. It could hardly be expected that there should be any special spot upon the earth's surface from which longitude would naturally be reckoned, and the whole question, apart from any sentimental or patriotic feelings, is therefore one of the greatest convenience. Were the employment of degrees of longitude as general geographical units entirely unheard-of up to the present time, it would, of course, be a matter of perfect indifference whether the datum was at Greenwich, Paris, the Ferroe Isles, or any other spot. The meridians most in use are those of the two former places, and when we come to consider that, as was pointed out, the shipping tonnage controlled by the Greenwich

[1] The following nations voted in favour of Greenwich:—Austria, Chili, Colombia, Costa Rica, Great Britain, Guatemala, Hawaii, Italy, Japan, Liberia, Mexico, Netherlands, Paraguay, Russia, Salvador, Spain, Sweden, Switzerland, Turkey, United States, and Venezuela.

standard of longitude is about 14,000,000 tons, while that controlled by the longitude of Paris amounts to 1,750,000 tons only, the preponderance of convenience in favour of the former is placed beyond all dispute. The use of nautical charts constructed from the meridian of Greenwich, and also of the Greenwich *Nautical Almanac*, is by no means confined to the British Navy, for numerous other nations have availed themselves of the long-extended labours of our hydrographers, and the computations of our astronomers. At the same time there is no one among us who would for a moment venture to dispute the vast services to science which have been rendered by French astronomers and geographers, nor should we contest the right of French *savants* to regard Paris as the *μεσόμφαλος ἑστία* of all other branches of science; the question of a common zero of longitude, however, is not only of scientific but of commercial importance, and we may be confident that eventually our friends on the other side of the Channel, whose metric system has been so largely adopted by other countries, will in their turn sacrifice their own meridian, and adopt that which all neighbouring countries have declared to be the most convenient for general use. If some French locality on the meridian of Greenwich, such for instance as Argentan, were nominally the French datum, the results would be the same so far as maps and charts are concerned, and the natural patriotism of the French nation would remain uninjured.

The adoption of a universal day has also been recommended by the Conference. It is to be a mean solar day to begin for all the world at the moment of mean midnight of the initial meridian, coinciding with the beginning of the civil day and date of that meridian, and is to be counted from zero up to twenty-four hours.

The great volcanic eruption of Krakatoa, in the Straits of Sunda, which took place in August of last year, was followed by remarkable atmospheric and other disturbances, observations on which have been communicated to this and various other learned Societies, and have led to much interesting discussion. The fact, as pointed out by General Strachey and Mr. Scott, that at some barometrical stations the atmospheric wave caused by the eruption was still to be traced until about 122 hours after its origin, and that it must have travelled more than three times round the entire circuit of the earth, shows how vast must have been the initial disturbance causing the wave. The possibility of the remarkable atmospheric appearances which so constantly accompanied the rising and setting of the sun for some months subsequent to the eruption being due to volcanic dust in suspension in the air, offered a farther incentive to investigate the whole history of the eruption. In consequence, the Council in January last nominated a Committee to collect the various accounts of the volcanic eruption at Krakatoa and attendant phenomena, in such form as shall best provide for their preservation and promote their usefulness, and a sum of 100*l.* in all has been granted from the Donation Fund to defray the expenses of the Committee. A Committee of the Royal Meteorological Society, which had already been appointed to study the sunset phenomena of 1883-84, joined forces with our Committee, and their united labours, with Mr. A. Ramsay as secretary, have resulted in the accumulation of a voluminous mass of material. The accounts given in the chief British and foreign scientific serials have been extracted and classified, and the times of the various observations reduced to Greenwich mean time.

The literature on the subject, as Mr. Symons informs me, seems almost inexhaustible, and the Committee, feeling that some limit must be adopted, have now stopped the collection of further data, and are engaged in the discussion of what have already been obtained. The manuscript is classified according to subjects, and each of these is being studied by the members of the Committee most familiar with it. It is to be hoped that in the ensuing session we shall be favoured with some of the results of their labours.

In the Presidential Address of last year mention was made of a series of borings which it was proposed to make across the delta of the Nile in Egypt, and which, with the sanction of the Secretary of State for War, had been intrusted to the officer commanding the Royal Engineers attached to the army of occupation in Egypt. Shortly afterwards a Report from Col. Heriot Maitland, R.E., and Major R. H. Williams, R.E., was received, giving an account of a boring at Kasr-el-Nil, near Cairo, which had been carried to a depth of 45 feet, and of a second boring at Kafr Zaiyat, where a depth of 84 feet was attained. In both cases great difficulties had to be surmounted, but in neither was the solid rock reached beneath the superficial deposits. A second Report from the same officers, dated January 18 last, states that a third boring had been executed at Tantah, this time by the sappers of the Royal Engineers, and not by Arab workmen, though still with but imperfect tools. In this instance a depth of 73 feet was reached, but again without finding the solid rock. Samples of the materials obtained at different depths in these three borings have been forwarded to the Society by the War Department, and Prof. Judd has kindly undertaken their microscopic examination, and will shortly report the results of his labours to the Committee in charge of the subject.

With regard to the continuance of the borings, which seem to promise information of great value and interest, it is to be feared that the attention of the military authorities will for some time to come be attracted to more urgent business, though the Council of this Society has expressed its willingness to grant from the Donation Fund a further sum of 200*l.*, with the view of obtaining better apparatus for boring than that which has hitherto been employed.

The publication of the results of the *Challenger* Expedition, with which a Committee of this Society is to some extent concerned, has made considerable progress during the past year. Mr. Murray informs me that 47 Reports, forming 13 large quarto volumes, with 6276 pages of letterpress, 1051 lithographic plates, many woodcuts, charts, and other illustrations, have now been published. Nine other Reports are now being printed, and the eleventh Zoological volume and the first Botanical volume will be issued during the present financial year.

The work connected with the remaining thirty-six memoirs is making satisfactory progress, a large instalment of the manuscript being already prepared, and many of the plates either already printed off or drawn on the stone.

There has been an unavoidable delay in the case of the two volumes containing the narrative of the cruise and a general account of the scientific results of the Expedition, but it is expected that they will be issued within the next three months, and possibly before the end of the current year.

It was estimated that the investigations connected with the collections and observations made during the Expedition would be completed and published in 1887, and Mr. Murray has every reason to believe that the work will be finished within the estimated time.

The tenth Zoological volume which has just been issued, contains important Reports on the Nudibranchiata, Myzostomida, and Cirripedia, by Drs. Rudolph Bergh, L. von Graff, P. P. C. Hoek, as well as on the Cheilostomata, a sub-order of the Polyzoa, by Mr. George Busk. A first instalment of the Anthropological Report is also given by Prof. William Turner, in a detailed examination of the human crania, upwards of 60 in number, brought home by the Expedition. The total number of crania, however, described and tabulated in the memoir is 143, the whole from aboriginal and as yet uncivilised people. The previous Zoological volume is devoted to an exhaustive examination of the Foraminifera, by Mr. H. B. Brady.

The subject of the International Polar Observations, which were carried out during the twelve months ending with August 1883, has been touched on in recent Presidential Addresses, and in that for 1881 the general outline of the whole scheme was indicated. Now, however, the programme then only sketched out has been more than fulfilled, no less than 14 stations for observers, 12 for the Northern and 2 for the Southern Hemisphere, having been organised. Of all the expeditions, one only, that from Holland, failed to reach its destination, Dickson Harbour, at the mouth of the Obi River, as it was beset by ice in the Kara Sea, in the month of September 1882. The ship which carried the members of the expedition sank in the month of July 1883, but they all reached home in safety, having carried out their observations as fully as lay in their power. One of the two expeditions sent out by the Chief Signal Office, Washington, was not so fortunate. The party under Lieutenant Greely, after spending over two years at Lady Franklin Bay, Smith's Sound, was eventually rescued at Cape Sabine, in July last, but not before many of its members had succumbed beneath the fearful hardships of their protracted Arctic sojourn.

The actual points of observation, going eastwards from Behring Straits, and the States which sent out the expeditions, are tabulated below: —

Point Barrow	The United States.
Fort Rae	Great Britain and Canada.

Lady Franklin Bay	The United States.
Cumberland Sound.........	Germany.
Godthaab	Denmark.
Jan Mayen	Austria.
Spitzbergen	Sweden.
Bossekop	Norway.
Sodankyla	Finland.
Nova Zemlya	Russia.
Mouth of the Lena ...	Russia.
The Kara Sea	Holland.
In the Southern Hemisphere—	
Cape Horn	France.
South Georgia..	Germany.

At all of these stations observations were carried on for a year, and at some for even a longer period.

In the month of April last a Conference was held at Vienna, to decide as to the form and mode of discussion and publication of the results, and it may be hoped that these will appear before the end of 1885.

Of the serial publication, "Communications from the International Polar Commission," six parts, with an aggregate of 334 pages, have already appeared, and in it will be found all particulars of the undertaking.

The regulations under which the Government Grant of 4000*l.* is administered have during the past year been again under discussion, and have in some respects been slightly modified. It is, of course, needless to repeat that this grant, though nominally made to the Royal Society, in no way adds to its funds, while its administration rests with a Committee of from sixty or seventy members, many of whom are not of necessity Fellows of our Society. As the grant is now made in two instalments, it has been arranged that the meetings of the Committee shall be held twice in each year, viz., in May and December, which it is hoped will amply meet the convenience of applicants for grants.

In looking back upon the grants which have been made during the past year, I think that a tendency may be observed on the part of the Committee to devote considerable sums in aid of extensive researches rather than to fritter away the money at their disposal in a series of small grants. They have, for instance, allotted the sum of 500*l.* towards the exploration of Kilimanjaro and the adjoining mountains of Tropical Africa, and 200*l.* in aid of an expedition for the exploration of the mountain of Roraima in British Guiana. A grant of 200*l.* has also been made towards a report on the Flora of China; while 300*l.* has been allotted towards the extra accommodation and instruments for magnetic observations in the new Observatory of the Royal Cornwall Polytechnic Society. It will be remembered that, in his Address last year, the President called attention to the discovery by Dr. Huggins of a method of photographing the solar corona without an eclipse; and, for the purpose of making further experiments in this direction, and for carrying on other physical observations at some place of high elevation and of easy access, a grant of 250*l.* was placed at the disposal of a Committee. The place of observation selected by the Committee was the Riffel, near Zermatt, in Switzerland, which has an elevation of 8500 feet, and possesses important advantages both of access, and of hotel accommodation. They appointed Mr. C. Ray Woods, who had had experience in photographing the corona during the eclipse of 1882 in Egypt, and again in Caroline Island in 1883, to take charge of the work under the instructions of Dr. Huggins and Capt. Abney.

Mr. Woods arrived at the Riffel in the beginning of July, when he erected the necessary instruments under a tent of "Willesdenised" paper, and continued at work there until September 21. Unfortunately, the present year has been exceptionally unfavourable for work on the corona, in consequence of an unusual want of transparency in the higher regions of the atmosphere. This probably may be owing to the presence there of ice-crystals or of small particles of matter of some kind, such as, personally, I am tempted to think might be due to the Krakatoa eruption. Whatever the cause, the sky as seen from the Riffel was far from being so clear as it has been during former years. Mr. Woods observed that the freer the lower air was from cloud and mist, the more distinctly came out a great aureola around the sun, which he found to have a diameter of about 44°, and to be of a faint red near the outer boundary, and bluish-white within, up to the sun's limb.

These unfavourable conditions of the atmosphere have made it impossible for Dr. Huggins to obtain any photographs of the corona in England. The great advantage at the Riffel of being free from the light scattered from the lower 8000 feet of air has enabled Mr. Woods, notwithstanding the serious drawback of the persistent aureola, to obtain about 150 photographs, of which more than half are sufficiently good to show the general form, and a smaller number the stronger details of that part of the corona which lies within from 8′ to 12′ of the sun's limb. It would be premature to express any opinion as to the information which may eventually come out from the Riffel plates. They are now being drawn preparatory to a full discussion. In the meantime I may congratulate the Society upon the confirmation of the hope expressed by our President at the last anniversary, "that a new and powerful method of investigation has been placed in the hands of students of solar physics."

Another of the grants made by the Committee has also contributed to important scientific results, as it has enabled Mr. Caldwell to make some important observations on the early stages of the Monotreme ovum, a brief account of which was communicated to the meeting of the British Association for the Advancement of Science at Montreal. A fuller account of the observations, such as is necessary for the adequate appreciation of their importance and bearings, will, I hope, be laid before the Society during the ensuing session, when we shall also probably hear the result of similar investigations in like manner rendered possible by the existence of the Government Grant.

Some slight aid has been rendered from the same source towards the reduction of observations carried on at the meteorological station on the summit of Ben Nevis. This Observatory, situated on the highest point within the United Kingdom, has through the past year been under the charge of Mr. R. T. Omond and two assistants. During the summer months the buildings of the Observatory have been enlarged by the addition of new observing-rooms and increased accommodation for the observers and any scientific workers who may desire to carry on those physical researches for which the climate and position of Ben Nevis afford many facilities.

The erection and equipment of the Observatory have cost more than 5000*l.*; and, in connection with the observations carried on at the top of the mountain, others have been daily made near the sea-level at Fort William. A first report on these conjoint high- and low-level observations, which began in 1881, has been prepared by Mr. Buchan ("*Journal* of the Scottish Meteorol. Soc.," 3rd Series, No. 1 (1884), p. 4). The monthly normals for atmospheric pressure and temperature have been approximately determined for the Observatory. Important results have also been obtained relating to the decrement of temperature with height, for different months of the year and hours of the day, the diurnal variations of the wind's velocity, the very large increase in the rainfall on and near the summit, and the altogether unexpected hygrometric conditions of the air in their relation to the cyclones and anticyclones of North-Western Europe.

Another of the funds at our disposal, the Scientific Relief Fund, requires a few words of mention. Its resources have been considerably enriched during the past year by the legacy of 1000*l.* from Sir William Siemens, and nearly 50*l.* from the medals offered by the executors of the late Lady Sabine; and the legacy of 1000*l.* from the late Mr. Bentham will, it is hoped, ere long be received; but even with these munificent additions the income of the fund will amount to only 250*l.* per annum, while last year the calls upon it amounted, I regret to say, to no less than 450*l.* The incalculable value of such a fund to men of science or their families requiring temporary aid must be apparent to all, and looking at the unfortunate necessity for its existence which the calls upon it prove, I venture to commend it to your support. It will, perhaps, not be out of place here to say a few words with regard to the administration of this fund, the existence of which dates from 1859, and is in a great degree due to the exertions of the late Mr. Gassiot. The Council of the Royal Society takes charge of any sums contributed to the fund and invests them, applying the interest in grants for the relief of such scientific men or their families as may from time to time require or deserve assistance. These grants are, however, made only on the recommendation of a committee of seven members who investigate the cases before them, and applications for relief cannot be entertained except on the recommendation of the President of one of the chartered Societies, viz., the Astronomical, Chemical, Geographical, Geological, Linnean, Royal, and Zoological Societies. Since January 1861, when the first grant was made, the total number of grants has been eighty-eight, and the total sum distributed 4340*l.*

Our Donation Fund has also proved of much service, and several of the applications for comparatively small amounts, which were referred by the Government Grant Committee for the consideration of the Council of the Royal Society, were met by grants from this source. This most valuable fund, the annual income of which is now about 400*l*., has, during the past year, rendered important aid to various scientific objects. From it considerable grants have been made towards obtaining specimens of Hatteria and Apteryx; for expenses incurred on account of the voyage and investigations of the surveying-ship *Triton*; for collection of materials relating to the Krakatoa eruption; towards the borings in the Delta of Egypt; and, lastly, in aid of the Marine Biological Association.

The close connection of the future of our fisheries with the advancement of certain branches of zoological science was commented upon by our President in his last Anniversary Address, and I have now to record the foundation of two establishments devoted to marine research. The first of these is the station established at Granton, near Edinburgh, mainly through the energetic labours of Mr. John Murray of the *Challenger* Expedition. It consists of a floating laboratory where physical and biological investigations are carried on, and it is provided with a steam yacht for taking observations at sea and procuring specimens for examination. Chemical and other laboratories are now being erected on the shore, close to the inclosed piece of water where the floating laboratory is moored. Two naturalists, a chemist and a botanist, are permanently attached to the station, and have an engineer, a fisherman, and three attendants to assist them in conducting regular systematic observations. 2500*l*. have been spent on the equipment of the station, and it has at present an income of 400*l*. a-year, independent of the grants which some of the permanent staff have received from the Government Grant Committee to aid them in their researches. It is well that it should be known that any scientific observer is at liberty to make use of the station free of charge; indeed, during the past year five gentlemen and one lady have availed themselves of this privilege during short periods of time.

But the movement in favour of such stations has not been confined to Scotland, for I have also to chronicle the foundation of the Marine Biological Association, which originated in a meeting held in these rooms on March 31 last, our President being in the chair, and many of our principal naturalists taking part in the proceedings. The formation of such an Association has long been hoped for by many interested in obtaining a correct knowlege of the life and conditions of our sea-coast, who are now principally indebted to Prof. Ray Lankester for the realisation of their hopes. The operations of the Association will in no way clash with those of the station at Granton, but both institutions will work towards a common end. One effect, indeed, of the new Association will probably be to render all the more fruitful the labours on the more northern shores by instituting similar researches at other parts of the coast of our island.

The work of the Association is as yet in the inceptive stage, but a site well adapted for a marine observatory will, through the liberal endeavours of the Mayor and Corporation of Plymouth, probably be secured in that town, some citizens of which have also promised a noble donation of 1000*l*. towards its erection. The Clothworkers' Company has contributed 500*l*. and the Mercers' Company 250 guineas, while the Council of this Society has also shown its sympathy with the movement by a grant of 250*l*., and the British Association by one of 150*l*. Handsome donations have also been made by private individuals, and the number of members of the Association is gradually increasing. When once the station is completed and at work, and its aims and operations become better known, I make little doubt that it will receive a much larger share of public support. But before the station can be erected and at work, it is calculated that an outlay of 10,000*l*. is necessary for its building and equipment, of which as yet not quite half is forthcoming, and I venture to take this opportunity of enforcing the claims of the Association upon all who are interested in "the improvement of natural knowledge." As has already been pointed out in the memorandum issued by the Association, "great scientific and practical results have been obtained in other countries, notably in the United States of America, in Germany, France, and Italy, by studies carried on through such laboratories as the Marine Biological Association proposes to erect in this country," and I may add as is already at work at Granton. When we consider the enormous importance of our fisheries, and how large may be the amount of material benefit derived from a scientific investigation of the causes of their increase and diminution, it will, I think, be evident that the work to be carried on at these stations is not only for such a purpose as the development of abstract biological science, important as that may be, but for the advancement of our national resources. It is, therefore, to be hoped that, in addition to the private support which they will receive, they may in some manner be recognised by the nation at large as centres for carrying out systematic investigations into the circumstances determining marine life, from which a portion of our food-supply is drawn, and a much larger portion might probably be derived. The importance of our sea fisheries, which it will be one of the principal objects of the Association to promote, has of late years been more fully recognised, and the recent International Fisheries Exhibition has done much to popularise the subject; while the official appointment of our President also proves that in the opinion of our Government the scientific aspects of our fisheries are not to be neglected.

In the last Presidential Address reference was made to the great desirability of carrying out, on the part of this country, investigations into the nature of cholera in continuation and extension of those so zealously and bravely initiated by the distinguished German inquirer Koch. Although the Society has had no very direct influence in the matter, the Fellows will, I venture to think, regard it as a subject for congratulation that the wish then expressed from this chair has been fulfilled, and that the distinguished expert in such questions—our Fellow, Dr. Klein—is at present engaged in India in the investigation of cholera at the instance of the Indian Government. It is sad to think how much nearer our own shores such investigations might have been conducted; may it be long ere they can be instituted on this side of the Channel.

These remarks have already extended to such a length that I can now only briefly refer to a few of the events of scientific interest which have during the past year occupied the attention of the Society or of a large number of its Fellows. In the month of April last the University of Edinburgh celebrated its Tercentenary with great pomp and no less hospitality, upwards of 120 delegates from various universities and other learned bodies being invited as guests. On this occasion Lord Rayleigh kindly consented to be our representative, and was among those on whom the University conferred the honorary degree of LL.D. The same distinguished Fellow occupied the Presidential chair at the meeting of the British Association for the Advancement of Science at Montreal, on which occasion many of our body took the opportunity of crossing the Atlantic. Owing to the munificent liberality and ungrudging hospitality of our brethren in the Dominion of Canada, the somewhat bold experiment of holding a meeting of the Association beyond the limits of the British Isles has proved a great success, though, perhaps, it is an experiment which would require exceptional conditions to be successfully repeated.

The Society was represented by delegates at the meeting of the American Association for the Advancement of Science at Philadelphia in September last. The Electrical Exhibition at the same place resulted in the formation of a Memorial Library in connection with the Franklin Institute, to which separate copies of the papers relating to electricity that have appeared in the *Philosophical Transactions* have been granted by the Council. An Electrical Congress at Paris, and an Ornithological one at Vienna have also been among the events of the year.

Subscribers to the Darwin Memorial Fund will be pleased to hear that a fine block of marble has been secured for the statue to be erected in the Natural History Museum at South Kensington, and I am glad to learn from Mr. Boehm that his work will probably be completed by the end of this year. When the total cost of the statue has been ascertained, it will be necessary to hold a meeting of the Committee in charge of the Memorial Fund to determine the manner in which the balance is to be applied.

It now only remains for me to thank the Fellows and others conversant with the subjects on which I have touched, for information kindly afforded me; to thank you for the attention with which you have listened to me, and to express a hope that it may not again for many years occur that the Anniversary Address from this Presidential chair shall have to be delivered by deputy.

After the Address the awards of the medals and the election of the Council for the ensuing year were proceeded with; these we

have already referred to. A gloom was cast over the meeting by the announcement of the sudden death of Prof. Kolbe, the distinguished recipient of the Davy Medal.

The Annual Dinner subsequently took place at Willis's Rooms, the Treasurer being supported by the Lord Chancellor, the Marquess of Salisbury, the Lord Mayor, and others.

THE WAVE THEORY OF LIGHT[1]

II.

To continue our study of visible light, that is, undulations extending from red to violet in the spectrum (which I am going to show you presently), I would first point out on this chart that in the section from letter "A" to letter "D" we have visual effect and heating effect only; but no ordinary chemical or photographic effect. Photographers can leave their usual sensitive chemically prepared plates exposed to yellow light and red light without experiencing any sensible effect; but when you get

The Solar Spectrum.

toward the blue end of the spectrum the photographic effect begins to tell, more and more as you get towards the violet end. When you get beyond the violet, there is the invisible light known chiefly by its chemical action. From yellow to violet we have visual effect, heating effect, and chemical effect, all three; above the violet only chemical and heating effects, and so little of the heating effect that it is scarcely perceptible.

The prismatic spectrum is Newton's discovery of the composition of white light. White light consists of every variety of colour from red to violet. Here, now, we have Newton's prismatic spectrum produced by a prism. I will illustrate a little in regard to the nature of colour by putting something before the light which is like coloured glass; it is coloured gelatine. I will put in a plate of red gelatine which is carefully prepared of chemical materials, and see what that will do. Of all the light passing to it from violet to red it only lets through the red and orange, giving a mixed reddish colour.

Here is another plate of green gelatine. The green absorbs all the red, giving only green. Here is another plate absorbing something from each portion of the spectrum, taking away a great deal of the violet and giving a yellow or orange appearance to the light. Here is another absorbing out the green, leaving red, orange, and a very little faint green, and absorbing out all the violet.

When the spectrum is very carefully produced, far more perfectly than Newton knew how to show it, we have a homogeneous spectrum. It must be noticed that Newton did not understand what we call a homogeneous spectrum; he did not produce it, and does not point out in his writings the conditions for producing it. With an exceedingly fine line of light we can bring it out as in sunlight, like this upper picture, red, orange, yellow, green, blue, indigo, and violet, according to Newton's nomenclature. Newton never used a narrow beam of light, and so could not have had a homogeneous spectrum.

This is a diagram painted on glass and showing the colours as we know them. It would take two or three hours if I were to explain the subject of spectrum analysis to-night. We must tear ourselves away from it. I will just read out to you the wave lengths corresponding to the different positions in the sun's spectrum of certain dark lines commonly called "Fraunhofer's lines." I will take as a unit the one-hundred-thousandth of a centimetre. A centimetre is ·4 of an inch; it is a rather small half an inch. I take the thousandth of a centimetre and the hundredth of that as a unit. At the red end of the spectrum the light in the neighbourhood of that black line "*A*" has for its wave length 7·6; "*B*" has 6·87; "*D*" has 5·89; the "frequency" for "*A*" is 3·9 times 100 million million; the frequency of "*D*" light is 5·1 times 100 million million per second.

Now what force is concerned in those vibrations as compared with sound at the rate of 400 vibrations per second; suppose for a moment the same matter was to move to and fro through the same range, but 400 million million times per second. The force required is as the square of the number expressing the frequency. Double frequency would require quadruple force for the vibration of the same body. Suppose I vibrate my hand again, as I did before. If I move it once per second a moderate force is required; for it to vibrate ten times per second 100 times as much force is required; for 400 vibrations per second 160,000 times as much force.

If I move my hand once per second through a space of a quarter of an inch a very small force is required; it would require very considerable force to move it ten times a second, even through so small a range; but think of the force required to move a tuning fork 400 times a second; compare that with the force required for a motion of 400 million million times a second. If the mass moved is the same, and the range of motion is the same, then the force would be one million million million million times as great as the force required to move the prongs of the tuning fork. It is as easy to understand that number as any number like 2, 3, or 4.

Consider gravely what that number means and what we are to infer from it. What force is there in space between my eye and that light? What forces are there in space between our eyes and the sun, and our eyes and the remotest visible star? There is matter and there is motion, but what magnitude of force may there be?

I move through this "luminiferous ether" as if it were nothing. But were there vibrations with such frequency in a medium of steel or brass, they would be measured by millions and millions and millions of tons action on a square inch of matter. There are no such forces in our air. Comets make a disturbance in the air, and perhaps the luminiferous ether is split up by the motion of a comet through it. So when we explain the nature of electricity, we explain it by a motion of the luminiferous ether. We cannot say that it is electricity. What can this luminiferous ether be? It is something that the planets move through with the greatest ease. It permeates our air; it is nearly in the same condition, so far as our means of judging are concerned, in our air and in the inter-planetary space. The air disturbs it but little; you may reduce air by air-pumps to the hundred-thousandth of its density, and you make little effect in the transmission of light through it. The luminiferous ether is an elastic solid. The nearest analogy I can give you is this jelly which you see.[1] The nearest analogy to the waves of light is the motion, which you can imagine, of this elastic jelly, with a ball of wood floating in the middle of it. Look there, when with my hand I vibrate the little red ball up and down, or when I turn it quickly round the vertical diameter, alternately in opposite directions;—that is the nearest representation I can give you of the vibrations of luminiferous ether.

Another illustration is Scottish shoemaker's wax or Burgundy pitch, but I know Scottish shoemaker's wax better. It is heavier than water, and absolutely answers my purpose. I take a large slab of the wax, place it in a glass jar filled with water, place a number of corks on the lower side and bullets on the upper side. It is brittle like the Trinidad pitch or Burgundy pitch which I have in my hand. You can see how hard it is, but if left to itself it flows like a fluid. The shoemaker's wax breaks with a brittle fracture, but it is viscous and gradually yields.

What we know of the luminiferous ether is that it has the rigidity of a solid and gradually yields. Whether or not it is brittle and cracks we cannot yet tell, but I believe the discoveries in electricity, and the motions of comets, and the marvellous spurts of light from them, tend to show cracks in the luminiferous ether—show a correspondence between the electric flash and the aurora borealis and cracks in the luminiferous ether. Do not take this as an assertion, it is hardly more than a vague scientific dream: but you may regard the existence of the luminiferous ether as a reality of science, that is, we have an all-pervading medium, an elastic solid, with a great degree of rigidity; its rigidity is so prodigious in proportion to its density that the vibrations of light in it have the frequencies I have mentioned, with the wave lengths I have mentioned.

The fundamental question as to whether or not luminiferous ether has gravity has not been answered. We have no knowledge that the luminiferous ether is attracted by gravity; it is sometimes called imponderable because some people vainly imagine that it has no weight. I call it matter with the same kind of rigidity that this elastic jelly has.

[1] A Lecture delivered at the Academy of Music, Philadelphia, under the auspices of the Franklin Institute, September 29, 1884, by Sir William Thomson, F.R.S., LL.D. (Continued from p. 94).

[1] Exhibiting a large bowl of clear jelly with a small red wooden bal embedded in the surface near the centre.

Here are two tourmalines; if you look through them toward the light, you see the white light all round, *i.e.* they are transparent. If I turn round one of these tourmalines the light is extinguished, it is absolutely black, as though the tourmalines were opaque. This is an illustration of what is called polarisation of light. I cannot speak to you about qualities of light without speaking of the polarisation of light. I want to show you a most beautiful effect of polarising light, before illlustrating a little further by means of this large mechanical illustration which you have in the bowl of jelly. Now I put in the lantern another instrument called a "Nicol prism." What you saw first were two plates of the crystal tourmaline which came from Brazil, I believe, having the property of letting light pass when both plates are placed in one particular direction as regards their axes of crystallisation, and extinguishing it when it passes through the first plate held in another direction. We have now an instrument which also gives rays of polarised light. A Nicol prism is a piece of Iceland spar, cut in two and turned, one part relatively to the other, in a very ingenious way, and put together again and cemented into one by Canada balsam. The Nicol prism takes advantage of the property which the spar has of double refraction, and produces the phenomenon which I now show you.

I turn one prism round in a certain direction and you get light, a maximum of light. I turn it through a right angle and you get blackness. I turn it one quarter round again and get maximum light; one quarter more, maximum blackness; one quarter more and bright light. We rarely have such a grand specimen of a Nicol prism as this.

There is another way of producing polarised light. I stand before that light and look at its reflection in a plate of glass on the table through one of the Nicol prisms, which I turn round, so. Now I must incline that piece of glass at a particular angle, rather more than 45°; I find a particular angle in which, if I look at it and then turn the prism round in the hand, the effect is absolutely to extinguish the light in one position and to give it maximum brightness in another position. I use the term "absolute" somewhat rashly. It is only a reduction to a very small quantity of light, not an absolute annulment as we have in the case of the two Nicol prisms used conjointly. Those of you who have never heard of this before would not know what I am talking about. As to the mechanics of the thing it could only be explained to you by a course of lectures in physical optics. The thing is this, vibrations of light must be in a definite direction relatively to the line in which the light travels.

Look at this diagram, the light goes from left to right; we have vibrations perpendicular to the line of transmission. There is a line up and down which is the line of vibration. Imagine here a source of light, violet light, and here in front of it is the line of propagation. Sound vibrations are to and fro; this is transverse to the line of propagation. Here is another, perpendicular to the diagram, still following the law of transverse vibration; here is another circular vibration. Imagine a long rope, you whirl one end of it and you send a screw-like motion running along; you can get the circular motion in one direction or in the opposite.

Plane polarised light is light with the vibrations all in a single plane, perpendicular to the plane through the ray which is technically called the "plane of polarisation." Circular polarised light consists of undulations of luminiferous ether having a circular motion. Elliptically polarised light is something between the two, not in a straight line, and not in a circular line; the course of vibration is an ellipse. Polarised light is light that performs its motions continually in one mode or direction. If in a straight line it is plane polarised light; if in a circular direction it is circularly polarised light; when elliptical it is elliptically polarised light.

With Iceland spar, one unpolarised ray of light divides on entering it into two rays of polarised light, by reason of its power of double refraction, and the vibrations are perpendicular to one another in the two emerging rays. Light is always polarised when it is reflected from a plate of unsilvered glass, or water, at a certain definite angle of 56° degrees for glass, or 52° for water, the angle being reckoned in each case from a perpendicular to the surface. The angle for water is the angle whose tangent is 1·4. I wish you to look at the polarisation with your own eyes. Light from glass at 56° and from water at 52° goes away vibrating perpendicularly to the plane of incidence and plane of reflection.

We can distinguish it without the aid of an instrument. There is a phenomenon well known in physical optics as "Haidinger's Brushes." The discoverer is well known in Philadelphia as a mineralogist, and the phenomenon I speak of goes by his name. Look at the sky in a direction of 90° from the sun, and you will see a yellow and blue cross, with the yellow toward the sun, and from the sun, spreading out like two fox's tails with blue between, and then two red brushes in the space at right angles to the blue. If you do not see it, it is because your eyes are not sensitive enough, but a little training will give them the needed sensitiveness.

If you cannot see it in this way try another method. Look into a pail of water with a black bottom; or take a clear glass dish of water, rest it on a black cloth and look down at the surface of the water on a day with a white cloudy sky (if there is such a thing ever to be seen in Philadelphia). You will see the white sky reflected in the basin of water at an angle of about 50°. Look at it with the head tipped to one side and then again with the head tipped to the other side, keeping your eyes on the water, and you will see Haidinger's brushes. Do not do it fast or you will make yourself giddy. The explanation of this is the refreshing of the sensibility of the retina. The Haidinger's brush is always there, but you do not see it because your eye is not sensitive enough. After once seeing it you always see it; it does not thrust itself inconveniently before you when you do not want to see it. You can readily see it in a piece of glass with dark cloth below it, or in a basin of water.

I am going to conclude by telling you how we know the wave lengths of light and how we know the frequency of the vibrations. We shall actually make a measurement of the wave length of the yellow light. I am going to show you the diffraction spectrum.

You see on the screen,[1] on each side of a central white bar of light, a set of bars of light variegated colours, the first one, on each side, showing blue or indigo colour about four inches from the central white bar and red about four inches farther, with vivid green between the blue and the red. That effect is produced by a grating with 400 lines to the centimetre, engraved on glass, which I now hold in my hand. The next grating has 3000 lines on a Paris inch. You see the central space and on each side a large number of spectra, blue at one end and red at the other. The fact that, in the first spectrum red is about twice as far from the centre as the blue, proves that a wave length of red light is double that of blue light.

I will now show you the operation of measuring the length of a wave of sodium light, that is a light like that marked "*D*" on the spectrum, a light produced by a spirit lamp with salt in it. The sodium vapour is heated up to several thousand degrees, when it becomes self luminous and gives such a light as we get by throwing salt upon a spirit lamp in the game of snap-dragon.

I hold in my hand a beautiful grating of glass silvered by Liebig's process with metallic silver, a grating with 6480 lines to the inch, belonging to my friend Prof. Barker, which he has kindly brought here for us this evening. You will see the brilliancy of colour as I turn the light reflected from the grating toward you, and pass the beam round the room. You have now seen directly with your own eyes these brilliant colours reflected from the grating, and you have also seen them thrown upon the screen from a grating placed in the lantern. With a grating of 17,000 lines—a much greater number of lines per inch than the other—you will see how much further from the central bright space the first spectrum is; how much more this grating changes the direction or diffraction of the beam of light. Here is the centre of the grating, and there is the first spectrum You will note that the violet light is least diffracted and the red light is most diffracted. This diffraction of light first proved to us definitely the reality of the undulatory theory of light.

You ask why does not light go round a corner as sound does. Light does go round a corner in these diffraction spectra; it is shown going round a corner, it passes through these bars and is turned round an angle of 30°. Light going round a corner by instruments adapted to show the result, and to measure the angles at which it is turned, is called the diffraction of light.

I can show you an instrument which will measure the wave lengths of light. Without proving the formula, let me tell it to you. A spirit lamp with salt sprinkled on the wick gives very nearly homogeneous light, that is to say, light all of one wave length, or all of the same period. I have a little grating which I take in my hand. I look through this grating and see that

[1] Showing the chromatic bands thrown upon the screen from a diffraction grating.

candle before me. Close behind it you see a blackened slip of wood with two white marks on it ten inches asunder. The line on which they are marked is placed perpendicular to the line at which I shall go from it. When I look at this salted spirit lamp I see a series of spectra of yellow light. As I am somewhat short-sighted I am making my eye see with this eyeglass and the natural lenses of the eye what a long-sighted person would make out without an eyeglass. On that screen you saw a succession of spectra. I now look direct at the candle and what do I see? I see a succession of five or six brilliantly coloured spectra on each side of the candle. But when I look at the salted spirit lamp, now I see ten spectra on one side and ten on the other, each of which is a monochromatic band of light.

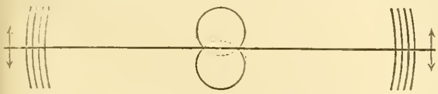
I will measure the wave lengths of light thus. I walk away to a considerable distance and look at the candle and marks. I see a set of spectra. The first white line is exactly behind the candle. I want the first spectrum to the right of that white line to fall exactly on the other white line, which is ten inches from the first. As I walk away from it I see it is now very near it; it is now on it. Now the distance from my eye is to be measured, and the problem is again to reduce feet to inches. The distance from the spectrum of the flame to my eye is thirty-four feet nine inches. Mr. President, how many inches is that? 417 inches, in round numbers 420 inches. Then we have the proportion, as 420 is to 10 so is the length from bar to bar of the grating to the wave length of sodium light. That is to say, as forty-two is to one. The distance from bar to bar is the four-hundredth of a centimetre: therefore the forty-second part of the four-hundredth of a centimetre is the required wave length, or the 16,800th of a centimetre is the wave length according to our simple, and easy, and hasty experiment. The true wave length of sodium light, according to the most accurate measurement, is about a 17,000th of a centimetre, which differs by scarcely more than 1 per cent. from our result!

The only apparatus you see is this little grating; it is a piece of glass with four-tenths of an inch ruled with 400 fine lines. Any of you who will take the trouble to buy one may measure the wave lengths of a candle flame himself. I hope some of you will be induced to make the experiment for yourselves.

If I put salt on the flame of a spirit lamp, what do I see through this grating? I see merely a sharply defined yellow light, constituting the spectrum of vaporised sodium, while from the candle flame I see an exquisitely coloured spectrum, far more beautiful than I showed you on the screen. I see in fact a series of spectrums on the two sides with the blue toward the candle flame, and the red further out. I cannot get one definite thing to measure from in the spectrum from the candle flame as I can with the flame of a spirit lamp with the salt thrown on it, which gives, as I have said, a simple yellow light. The highest blue light I see in the candle flame is now exactly on the line. Now measure to my eye, it is forty-four feet four inches, or 532 inches. The length of this wave then is the 532nd part of the four-hundredth of a centimetre, which would be the 21,280th of a centimetre, say the 21,000th of a centimetre. Then measure for the red, and you would find something like the 11,000th for the lowest of the red light.

Lastly, how do we know the frequency of vibration?

Why, by the velocity of light. How do we know that? We know it in a number of different ways, which I cannot explain now, because time forbids. Take the velocity of light. It is 187,000 British statute miles per second. But it is much better to take a kilometre for the unit. That is about six-tenths of a mile. The velocity is very accurately 300,000 kilometres per second; that is, 30,000,000,000 centimetres per second. Take the wave length as the 17,000th of a centimetre, and you find the frequency of the sodium light to be 510 million million per second. There, then, you find a calculation of the fre-



Vibrating spherule embedded in an elastic solid.

quency from a simple observation which you can all make for yourselves.

Lastly, I must tell you about the colour of the blue sky which was illustrated by the spherule embedded in an elastic solid. I want to explain to you in two minutes the mode of vibrations. Take the simplest plane polarised light. Here is a spherule which is producing it in an elastic solid. Imagine the solid to extend miles horizontally and miles down, and imagine this spherule to vibrate up and down. It is quite clear that it will make transverse vibrations similarly in all horizontal directions. The plane of polarisation is defined as a plane perpendicular to the line of vibration. Thus, light produced by a molecule vibrating up and down, as this red globe in the jelly before you, is polarised in a horizontal plane, because the vibrations are vertical.

Here is another mode of vibrations. Let me twist this spherule in the jelly as I am doing it, and that will produce vibrations, also spreading out equally in all horizontal directions. When I twist this globe round, it draws the jelly round with it; twist it rapidly back, and the jelly flies back. By the inertia of the jelly the vibrations spread in all directions, and the lines of vibration are horizontal all through the jelly. Everywhere, miles away, that solid is placed in vibration. You do not see it, but you must understand that they are there. If it flies back it makes vibration, and we have waves of horizontal vibrations travelling out in all directions from the exciting molecule.

I am now causing the red globe to vibrate to and fro horizontally. That will cause vibrations to be produced which will be parallel to the line of motion at all places of the plane perpendicular to the range of the exciting molecule. What makes the blue sky? These are exactly the motions that make the blue light of the sky, which is due to spherules in the luminiferous ether, but little modified by the air. Think of the sun near the horizon; think of the light of the sun streaming through and giving you the azure blue and violet overhead. Think first of any one particle of the sun, and think of it moving in such a way as to give horizontal and vertical vibrations and what not of circular and elliptic vibrations.

You see the blue sky in high-pressure steam blown into the air; you see it in the experiment of Tyndall's blue sky, in which a delicate condensation of vapour gives rise to exactly the azure blue of the sky.

Now the motion of the luminiferous ether relatively to the spherule gives rise to the same effect as would an opposite motion impressed upon the spherule quite independently by an independent force. So you may think of the blue colour coming from the sky as being produced by to-and-fro vibrations of matter in the air, which vibrates much as this little globe vibrates embedded in the jelly.

The result in a general way is this: The light coming from the blue sky is polarised in a plane through the sun, but the blue light of the sky is complicated by a great number of circumstances, and one of them is this, that the air is illuminated not only by the sun but by the earth. If we could get the earth covered by a black cloth, then we could study the polarised light of the sky with simplicity, which we cannot do now. There are, in Nature, reflections from seas and rocks and hills and waters in an indefinitely complicated manner.

Let observers observe the blue sky not only in winter when the earth is covered with snow, but in summer when it is covered with dark green foliage. This will help to unravel the complicated phenomena in question. But the azure blue of the sky is light produced by the reaction on the vibrating ether of little spherules of water, of perhaps a fifty-thousandth or a hundred-thousandth of a centimetre diameter, or perhaps little motes, or lumps, or crystals of common salt, or particles of dust, or germs of vegetable or animal species wafted about in the air. Now what is the luminiferous ether? It is matter prodigiously less dense than air—millions and millions and millions of times less dense than air. We can form some sort of idea of its limitations. We believe it is a real thing, with great rigidity in comparison with its density, and it may be made to vibrate 400 million million times per second and yet with such rigidity as not to produce the slightest resistance to any body going through it.

Going back to the illustration of the shoemaker's wax: if a cork will in the course of a year push its way up through a plate of that wax when placed under water, and if a lead bullet will penetrate downwards to the bottom, what is the law of the resistance? It clearly depends on time. The cork slowly in the course of a year works its way up through two inches of that substance; give it one or two thousand years to do it and the resistance will be enormously less; thus the motion of a cork or bullet, at the rate of one inch in 2000 years, may be compared with that of the earth, moving at the rate of six times ninety-three million miles a year, or nineteen miles per second, through the lumi-

niferous ether; but when we have a thing elastic like jelly and yielding like pitch, surely we have a large and solid ground for our faith in the speculative hypothesis of an elastic luminiferous ether, which constitutes the wave theory of light.

SCIENTIFIC SERIALS

Bulletin de la Société de Géographie, Paris, 3 Trimestre, 1884.—The principal portion of this number is occupied by papers of M. Huber, who spent the years 1878 to 1882 in Arabia on a scientific mission on behalf of the Department of Public Instruction. In the first he introduces 145 inscriptions which he found in various parts of Central Arabia on rocks. The second article is the first instalment (accompanied by a map) of an account of his numerous and extensive journeys in the same region, from Palmyra and Bagdad in the north, to Kheiber in the south. A glance at the route map shows that he has explored the greater part of this region during his prolonged stay there.—M. Petitin, in his account of his journey in Indo-China, gives a lengthy description of the difficulties and dangers which the traveller encounters in this peninsula. He was selected by Admiral de la Grandière when Governor of Saigon to make a geological investigation of Cochin-China, Siam, Hainan, and Formosa, but the death of the governor and the appointment of another whose views were different cut M. Petitin's explorations short. He saw enough, however, to give a brief account of the geology of Cochin-China, and to give the intending traveller much advice as to his arrangements and preparations. He also urges his countrymen to extend their dominion in the Indo-Chinese peninsula, especially in Tonquin, where the Red River affords them an opening into the heart of China.—M. la Meslle's paper on the eastern provinces of Australia is little more than a lively account of a journey in Queensland, while the object of M. Simonin's article on the ports of Great Britain—especially London, Liverpool, and Glasgow—is not quite apparent, unless it be to urge his countrymen to go and do likewise with their ports.

Verhandlungen der Gesellschaft für Erdkunde zu Berlin, Band xi., Nos. 6 and 7.—Herr Müller-Beeck, in the trade of Further India deals largely with trade routes into the Shan States and China. The Songkoi route into Yunnan he regards as one of great difficulty on account of the rapids. The delta also is constantly extending. Hanoi is now 110 miles from the sea; in the seventeenth century it was only half that distance. For half the year the upper part of the river is only navigable for boats of four tons, and when Manhao is reached, there is still a difficult land journey to Yunnan. The population also, he thinks, will form a grave obstacle to any regular trade by this channel.—Herr Buchta, in the Soudan and the Mahdi, deals purely with the political side of the Soudan question.—Prof. Seelstrang gives much interesting geographical and statistical information about the province of Santa Fé, in the Argentine Republic.—The usual notices of other societies and of new books conclude the number.

SOCIETIES AND ACADEMIES

London

Linnean Society, November 20.—Prof. P. Martin Duncan, F.R.S., Vice-President, in the chair.—Mr. A. Roope Hunt was elected a Fellow.—Mr. F. B. Forbes drew attention to specimens of pods and seeds used by the Chinese in place of soap. He stated that for ordinary detergent purposes an impure earthy soda and a lye made from ashes are employed. The leaves of *Hibiscus syriacus* and *Ginko biloba* are occasionally used for cleansing the head. The most favourite substance, however, is the fruit of certain Leguminosæ (Fei-tsao-tow). The late Daniel Hanbury figures these seeds as a species of *Dialium*. Dr. Porter Smith says they are the product of the *Acacia concinna* (*Mimosa saponaria*, Roxb.). Dr. Breitschneider asserts, on the contrary, that they belong to *Gymnocladus chinensis*, originally described by Baillon from pods only. Specimens at Kew lately figured in the "Icones Plantarum," are young leaves, fruit, and flowers from Foochow; those now exhibited (by Mr. Forbes) are, however, much finer examples from Ningpo and Wahu. The pods are roasted and kneaded into small balls used for washing clothes, and the head in bathing, but, on account of their unpleasant smell, they are prohibited in the public baths. The pods of *Gleditschia sinensis*, Lamk. (Tsao-chio) are used for the same purposes as *Gymnocladus*, those shown at the meeting being from Pekin and Shanghai district. One appears to answer to Dr. Hance's new *G. xylocarpa*. Bentham refers a South China tree to *G. sinensis*. Lamarck founded his species on a tree growing in the Jardin des Plantes, raised from seeds sent by Père Incarville 200 years ago from Pekin. It is doubtful if the northern and southern plants are identical. The pods are broken into small bits soaked in boiling water until an oily substance is floated, when they are ready for use. Another saponaceous substance is derived from *Sapindus makarosi* (the *S. chinensis* or *Kolreuteria paniculata*, Lam.), specimens of which were shown from Ningpo.—Messrs. H. and J. Groves exhibited specimens of (1) *Chara connivens*, collected at Slapton, South Devon, the only known British station, for no trace of the plant is now to be found at Stokes Bay; (2) *Chara canescens*, obtained from a pool between Helston and the Lizard, West Cornwall, by Messrs. Guardia and Groves, and also at Little Sea, Studland, Dorset, by Mr. Mansell Pleydell.—Mr. Geo. Murray showed dried and moistened examples of an Algæ, *Glœocapsa*, found by Mr. Pryer in birds'-nest caves in North Borneo.—Mr. J. G. Baker read the following letter from Mr. W. Brockhurst, of Didsbury, dated November 17, 1884:—"On April 2 I had the pleasure of exhibiting to the Society a number of prepared specimens of the daffodil, which appeared to prove that double daffodil flowers might produce seeds, and I advanced some arguments, based upon the observations I had made, to show that they were spread over wide areas in a wild state of seeding. The specimens showed the seed-vessels filled with ovules, but this did not fully prove that ripe seeds capable of germination would be matured. I therefore carefully observed a number of flowers of double daffodils (*Narcissus telamoneus-plenus*), and marked them as they went out of bloom, to prevent any mistakes. One of these produced a capsule containing nine shining black seeds, which were gathered on June 24, and at once sowed in a pot, and covered with a sheet of glass. Of these seeds four have already germinated, and show grass-like growths an inch above the soil. This therefore completes the proof."—Mr. W. T. Thiselton Dyer pointed out and made remarks on some sterile runners of *Mentha piperita*, and the remains of flowers of *Epilobium hirsutum*, both taken from a wreath found by Prof. Maspero in a tomb near Thebes, and supposed to be of the 20th or 26th dynasty; Mr. Dyer also exhibited fresh flowers of *Ipomea purpureo-cœrulea*.—Mr. Thos. Christy exhibited two specimens of *Lycaste Skinneri*, Lindl., one with two flowers on one stem, the other with an aborted lip adherent for the greater part of its length to the column. He also drew attention to samples of the tea (probably a species of *Ilex*) used largely in Bogota, but which is said to be deficient in flavour.—Mr. E. C. Stanford thereafter showed some of the products from seaweed, viz.:—Algin, the insoluble form of which (alginic acid) can be made into shirt-studs resembling horn, &c.; the soluble algin (or alginate of soda), which diminishes the brittleness of shellac, besides other uses.—A paper was read by Mr. E. M. Holmes on *Cinchona Ledgeriana* as a species. The author expressed the opinion that under the name of *C. Ledgeriana*, a number of varieties or forms, and probably some hybrids of *Cinchona Calisaya*, are now under cultivation in the British colonies. He believed that, if more attention were paid to the characters afforded by the bark of trees, taken in conjunction with the other botanical characters of flower and fruit, these varieties and hybrids would be more easily defined and recognised. He considers that the plant published under the name of *C. Ledgeriana* by Dr. Trimen was probably referable to Weddell's *Cinchona Calisaya*, var. *pallida*, as a horticultural form, for which the author proposed the name "*Trimeniana*."—A paper was read, notes on the habits of some Australian Hymenopterous Aculeata, by H. L. Roth. He states that the wasps of the genus *Pelopœus* (*P. lœtus*) build their nests on the walls, ceilings, legs of chairs, under the table, in cupboards, vases, between pictures and the walls, on curtains, in all sorts of crevices in the house, and on the roof. No place is safe from their intrusion. When a cell is completed, the wasp goes in search of spiders, and, seizing these, packs their half-dead bodies in the cell, lays an egg, and closes the cell-top; thereafter rows of cells are added to the primary one and dealt with in the same fashion, generally finishing with a streaked coating of mud, thus to deceive as to the real contents beneath. These wasps are infested with Dipterous parasites. Of the Australian ants, *Formica rufinigro* is numerous, bold, and destructive. They destroy the web of certain caterpillars and wriggle them out, when they fall a prey to a host of attendant

warrior ants.—Mr. E. T. Druery read a paper on a singular mode of reproduction in *Athyrium filix-fœmina*, var. *clarissima*. In a previous paper the author had shown that prothallia-bearing antheridia and archegonia were developed on the apex of pear-shaped bodies with the larger end downwards, in the place usually occupied by sori. In the present paper he brought forward evidence to show that these pear-shaped bodies were not developed from sporangia, but from a previous formation of thread-like bodies, a few of which became thickened, and developed into the pear-shaped bodies previously mentioned, the others remaining starved and undeveloped.

Zoological Society, November 18.—Prof. W. H. Flower, F.R.S., President, in the chair.—A communication was read from Mr. J. G. F. Riedel, C.M.Z.S., containing comments on certain passages in Mr. H. O. Forbes's paper on Timor-Laut birds, read before the Society on June 17.—A communication was read from Mr. H. Pryer, C.M.Z.S., giving an account of a recent visit to the edible-birds'-nest caves of British North Borneo In illustration of this paper, Mr. Pryer sent specimens of the swift (*Collocalia fuciphaga*), of its nest and eggs, of the *Alga* on which the bird was supposed to feed, and of the bat which inhabited the same caves.—Mr. Sclater read an account of some skins of mammals from Somali-land, which belonged apparently to five species. Amongst these was an apparently new form of wild ass, which was proposed to be called *Equus asinus somalicus*.—Mr. F. E. Beddard read a paper on the anatomy of the Umbrette (*Scopus umbretta*). The author observed that, as regards its exact systematic position, which had been hitherto a matter of doubt, he was inclined to place this peculiar form as a type of a separate family, between the herons (Ardeidæ) and the storks (Ciconiidæ).—A second paper by Mr. Beddard contained the results of some recent investigations into the structure of *Echidna*, and related to the presence of a persistent umbilical vein in that animal.—Captain Shelley read a paper on some new or little-known species of East African birds. Three of these were described under the names *Muscicapa johnstoni*, *Pratincola axillaris*, and *Nectarinia kilimensis*. The collection, which contained altogether ninety-four specimens, referable to thirty-eight species, was the first-fruits of Mr. H. H. Johnston's expedition to Kilimanjaro.—A communication was read from Mr. J. H. Gurney, F.Z.S., on the geographical distribution of *Huhua nipalensis*, with remarks on this and other allied species of owls.

Chemical Society, November 20.—Dr. Perkin, F.R.S., in the chair.—The following gentlemen were elected Fellows:—F. Broughton, F. J. Down, L. Ehrmann, F. G. Holmes, J. Hulme, C. Thompson, W. F. Wigley.—The following papers were read:—On some new paraffins, by Khan B. B. Sobrabji. The author has prepared cetane boiling at 278°, dicetyl melting at 70°, ethylcetyl and diheptyl.—On additive and condensation compounds of diketones with ketones, by F. R. Japp and N. H. J. Miller. The authors have studied the action of potash of various strengths on mixtures of phenanthraquinone and acetone. Additive compounds were obtained containing one molecule of the first substance to two of acetone, and another containing two molecules of phenanthraquinone to one of acetone. Condensation compounds were formed from the above additive compounds by the abstraction of the elements of water. The authors have also studied the action of potash upon mixtures of benzil with acetone and with acetophenone respectively, and have obtained acetobenzil and acetophenonebenzil.—On the vapour-pressure of acetic acid, and on a new method of determining the vapour-pressures of liquids, by W. Ramsay and Sydney Young. The authors have used a species of still into which a thermometer dips, the bulb of which is covered with cotton-wool moistened with the liquid. On heating, the liquid evaporates from the cotton-wool without ebullition. Results obtained agree with those obtained in the ordinary way. Perfectly concordant and regular results have been obtained with acetic acid.—On the action of the halogens on the salts of trimethylsulphine, by L. Dobbin and Orme Masson. The authors conclude that all the haloid salts of trimethylsulphine combine directly with chlorine, bromine, iodine, and iodine monochloride. In no case is one halogen replaced by the other. The authors have partly investigated the action of the halogens on trimethylsulphine sulphate.—Note on the heats of dissolution of the sulphates of potassium and lithium, by S. U. Pickering. The salts do not seem to form isomeric modifications such as exist in the case of sodium sulphate.—On the application of iron sulphate in agriculture and its value as a plant food, by A. B. Griffiths. The author finds that half a hundredweight of sulphate of iron per acre increased the yield of beans from 28 bushels to 44 bushels, of turnips from 13 tons to 16½ tons, but little effect was produced on cereals.—Notes on the chemical alterations in green fodder during its conversion into ensilage, by C. Richardson. The author confirms the results obtained by Kinch and Kellner, that a considerable increase in the non-albuminoid nitrogen takes place in the conversion: no such change occurs during the ordinary drying of fodder. The author used maize in his experiments.—On the decomposition of silver fulminate by hydrochloric acid, by E. Divers and Michitada Kawakita. The authors have studied the action of dilute and strong hydrochloric acid on this salt. With dilute acid the principal products are hydroxyammonium chloride and formic acid; if the acid is strong, much ammonium chloride is produced. A small quantity of hydrocyanic acid is always formed. They could not obtain any oxalic acid by decomposing mercury fulminate with hydrogen sulphide in ether. They have also studied the action of hydrochloric acid on fulminurates.

Paris

Academy of Sciences, November 24.—M. Rolland, President, in the chair.—Experiments with the chlorhydrate of cocaine (continued), by M. Vulpian. Further experiments made on snails (*Helix pomatia*) and fresh-water prawns (*Astacus fluviatilis*, F.) show that this anæsthetic is less efficacious in the case of invertebrate than vertebrate animals.—Note on the algebraic relations between hyperelliptic functions of the *n* order, by M. Brioschi.—On some reactions of the sulphuret of carbon, and on the solubility of this substance in water, by MM. G. Chancel and F. Parmentier.—Remarks by M. Daubrée on M. Nordenskjöld's "Voyage Round Europe and Asia," in connection with the French translation of that work presented to the Academy.—Note on the action of heat on electric piles, and on the law of Kopp and Wœstyne, by M. G. Lippmann.—Statistical note on cholera in the Paris hospitals since the outbreak of the epidemic on November 4 till the present time, by M. Emile Rivière. During this period 971 patients (579 men, 392 women) were treated in the various hospitals. Of these, 511 succumbed (302 men, 209 women), and 239 (129 men, 110 women) have so far been completely cured. The mortality has thus been 52·33 and 53·31 for men and women respectively. The working classes—rag-gatherers, seamstresses, washerwomen, masons, bricklayers, and shoemakers—have supplied the largest relative number of victims. These have almost invariably been persons of feeble constitution, subject to chronic disorders, exhausted by previous excesses, exposed to extreme physical destitution, or dwelling in the lowest slums of the French capital and its suburbs.—Remarks on the second instalment of the new map of Tunis prepared in the War Office on a scale of 1 : 200,000, by Col. Perrier. This instalment comprises six sheets, embracing the districts of Kef, Kairwan, Mahedia, Feriana, El Jem, and Sfax, based on surveys executed on the spot.—Presentation of the "Annals of the Ouro-Preto School of Mines," by the Emperor Dom Pedro II., with remarks by M. Daubrée.—On the condensation of the solar nebula on the hypothesis of Laplace, by M. Maurice Fouché.—Remarks on the nature of the curve known as Poinsot's erpolodie, by M. de Sparre.—On the involution of superior dimensions, by MM. J. S. and M. N. Vanecek.—Dynamo-electric machines: experimental confirmations of the two reactions, on the effective values of the inner resistance and of the inductor magnetism, by M. G. Cabanellas.—Action of water on the double salts, by M. F. M. Raoult.—On the composition of the gaseous products resulting from the combustion of pyrite, by M. Scheurer-Kestner.—New experiments on the rotation of crops in connection with the cultivation of beetroot, by M. P. P. Dehérain.—On the appearance and spread in France of the parasite of the beetroot known as *Heteredora Schachtii*, by M. Aimé Girard. To this parasite, the author thinks, is largely due the partial failure of this year's crop, which showed a deficit of 20 per cent. in the weight of the roots, besides a decrease in the yield of saccharine, which in some of the northern districts amounted to 12 or 14 per cent.—On the formation of vegetable acids in combination with potassa and lime bases, on the nitric substances and the nitrate of potassa developed in the saccharine plants, beetroot and maize, by M. H. Leplay.—On the characteristic smell and toxic effects of the products of fermentation produced by the comma-bacillus of cholera, by MM. W. Nicati and M. Rietsch.—On

cholera and cholemia, by M. W. Nicati. From the experiments recently made in the chemical laboratory of the Faculty of Sciences at Marseilles it seems established that biliary acids are relatively more abundant in the blood of the victims of cholera than in others. But the author is unable yet to decide whether in their case death is to be attributed to cholemia.—Note on infectious and parasitic pneumonic affections, by M. Germain Sée.—Experiments on the efficacy of disinfecting agents in the case of chicken cholera, by M. Colin.—On the virulence of the bubo accompanying soft chancre, by M. I. Straus.—On the luminous intensity of the spectral colours; influence of the state of the retina in determining light effects, by M. H. Parinaud.—On the appendices to the jaw of grinding insects, by M. Joannes Chatin.—On the floral polymorphism and the fertilisation of *Lychnis dioica*, L., by M. L. Crié.—Remarks on Dr. Ladislas Szajnocha's memoir on the Cephalopods of the Elobi Islands, West Coast of Africa, by M. Daubrée.

BERLIN

Meteorological Society, November 4.—Dr. Hellmann, following up an account of the most recent works in the department of meteorological literature, which he concluded with a full discussion of Mr. Blanford's rain-map of India, communicated his own observations regarding the rain conditions prevailing in Heligoland. The measurements there obtained had given an annual rainfall of 72·50 inches, an amount far surpassing that which had been observed at any of the neighbouring stations on the west coast of Schleswig and at the mouth of the Elbe. The speaker, having last summer made a tour of inspection, and convinced himself, from the instruments in use and their situation, of the accuracy of the registrations above referred to, explained the excessive rainfall in Heligoland by the circumstance that the steep coast, shooting up almost perpendicularly to about 164 feet above the level of the sea, forced the moist sea winds suddenly aloft, and so caused them to cool and condense both very rapidly and to a great extent. For the sake of testing the correctness of this explanation he had got another rain-gauge set up on the dunes at about 16 feet above sea-level, the registrations of which would next year be compared with those at the higher level. A second point in which the rain conditions of Heligoland deviated from those observed at the neighbouring stations on the coast respected the annual course of the rainfall. It was found that in North-West Germany the rainfall indicated a minimum in the middle of April and a maximum in August. In Heligoland, on the other hand, though indeed the minimum of rainfall occurred likewise in the middle of April, the maximum was attained in November. Dr. Hellmann sought an explanation of the postponement of the rain maximum in this latter case in the circumstance that in the yearly course of the temperature of the water and the atmosphere the difference between the two was greatest in November, the water at that time showing a temperature as much as 3°·6 F. warmer than that of the air.—Prof. Spörer gave a brief sketch of the present period of sun-spots. The spot periods being counted from minimum to minimum, the commencement of the present spot period was to be referred to 1878·8. So far as had been hitherto observed the present was distinguished from the two last spot periods by two peculiarities; first, that the maximum in the present period appeared to have occurred 0·4 of a year later than in the previous periods, and, second, that during the maximum the distribution of the solar eruptions showed an essentially different character from that usually obtaining. In the former periods it was observed during the maximum that the greatest concourse of spots surrounded with faculæ occurred in the median latitudes of the sun, that they were completely wanting towards the poles, became less numerous also towards the equator, and only at the equator itself did they again become somewhat more crowded. In the rotation of the sun those eruptions showed a heliographic displacement towards the equator, in contrast to the spots free from faculæ which, in the course of rotation, wandered towards the poles. During the minima of the spot periods the maximum of the eruptions was generally found in the neighbourhood of the equator. In the present period, again, the greatest concourse of eruptions surrounded with faculæ was found towards the equator during the maximum as well, a phenomenon usually occurring at the time of the minimum. The present, on the other hand, resembled former periods in the circumstance that it was only on rare occasions that the concourse of spots was alike on both hemispheres of the sun. In the majority of cases either the northern hemisphere presented a more copious display of spots than the southern, or the southern mustered them in larger numbers than the northern.

STOCKHOLM

Academy of Sciences, November 12.—Prof. Gyldén communicated the results of the Meridian Conference in Washington, according to the report of the Swedish delegate Count Lewenhaupt, and gave an account of his own paper "On the origin of comets."—Prof. Lindström exhibited a fossil scorpion recently found near Wisby in the Silurian formation of Gotland, and remarkable as the most ancient air-breathing land-animal at present discovered.—Prof. Retzius presented the last volume of his great work "Das Gehörorgan der Wirbelthiere," and made some remarks on its contents.—Prof. Nordenskjöld communicated a "Catalogue of the Meteorites in the Swedish Museum of Natural History," by Herr G. Lindström, Assistant Mineral Department.—Prof. Wittrock gave an account (1) of a paper by Dr. Johansson, of Upsala, "On Fungi from Iceland," and (2) of another paper by Dr. Alb. Nilsson "On the mechanical function of the sheaths of *Dianthus banaticus*, Heuff."—The Secretary presented the following papers:—On a quantity of the electrical potential, by Prof. Dahlander.—Sur la sommation des puissances semblables des *n* premiers nombres entiers, by Dr. C. O. Boije, of Gennäs.—On some recently-published mathematical papers from the seventeenth century by Bierens de Haan, by Dr. G. Eneström.—On a proposition from the theory of the elliptic functions, by E. Phragmén.—On substituted cyanamides and melanins, by Dr. P. Claësson.—On *Mergus anatarius*, Eimbeck, found in Sweden, by G. Kolthoff.—On a new Isopod from the coast of Sweden, by Dr. C. Bowallius.—On minerals occurring at Vestra Silfberg, by Dr. Mats Weibull.—A catalogue of the phænogamous plants and ferns of Jemtland, by Dr. P. Olsson.

VIENNA

Imperial Academy of Sciences, October 23.—Report on his journeys in the Balkan Peninsula, by F. Toula.—The geological exploration of the Central Balkans and adjacent regions, by the same.

CONTENTS

THURSDAY, DECEMBER 11, 1884

HEALTH LABORATORIES AS THE RESULT OF THE HEALTH EXHIBITION

MEN of science have thus far regarded the South Kensington Exhibitions of the last two years with very languid interest, if not with some suspicion. There has been throughout some show of scientific intent and much promise of serious result. Needless to say, however, that in regard to the Fisheries Exhibition, whatever may be in store for the future, very little of what was promised of solid or scientific result has thus far been definitely realised. That Exhibition achieved a certain success in technical interest and much was hoped in financial result, but there has been a remarkable reticence in respect to the surplus obtained and its proposed disposal. Little, if anything, has been announced in reply to the urgent requests that have been put forward for information on this subject as to the promotion of new knowledge which should aid the protection of the harvest of the sea, or help to give us information, of which we stand sadly in need, as to the best means of favouring the growth and hindering the destruction of the marine staple of food. So far the Marine Biological Association, which has been started by voluntary effort, has not received any promise of or share in the large sum of money which must now be standing to the credit of the Fisheries' Council. That body are in the happy position of having a continuing receipt as lessors of the buildings just vacated by the International Health Exhibition; they will receive a handsome sum for the next two years at least, and probably also in the succeeding years, from the Exhibitions already planned and in course of arrangement. They have a future before them rich in golden promise, and it is much to be hoped that they will not be unmindful of the new Marine Association. The Council of the International Health Exhibition have been more prompt in declaring the results of their work and in announcing some of its probable issues. Of this Exhibition also it was said, while its doors were open, that the element of display and of public attraction appeared to be much more prominent than did the scientific and solid objects which the great body of busy chemists, sanitarians, and engineers were summoned to assist by their work on the General Committees and on the juries. It will be found, however, by the statement which Mr. Ernest Hart makes in another column of the work done and the results achieved, that, although the serious side of the Exhibition was much less a subject of comment than its more entertaining features, the Council have steadily held the former in view and are likely still to do so in the proposed disposal of the surplus in promoting solid objects of national importance. In this Exhibition for the first time the Council went outside the ordinary routine of exhibits obtained from commercial or speculative sources, and at their own cost brought together and created departments of which the object was purely educational. Thus on the sanitary and unsanitary houses there appears to have been expended nearly 1000*l*., and probably much more than that on the literature of the Exhibition, including a considerable series of hand-books by skilled persons, devoted to the popular exposition of public and private hygiene, and the reports of conferences and lectures. A library was brought together of sanitary and educational works—about five thousand in number. Although far from complete, it was in many departments, especially in those relating to civic, official, and foreign sanitation, more extensive than any that had yet been collected. Of this an excellent printed catalogue was prepared, which is of itself a useful book of reference. Besides this, and perhaps far more important, was the creation of two health laboratories, under the direction of Profs. Corfield and Cheyne. By special application to the French Government a full exhibit was also obtained, illustrating the nature of the work and showing the instruments employed by M. Pasteur and M. Mique in their respective institutes. It is well known that laboratories of this kind are especially important for the scientific study of the bacteriological problems which have to be worked out, and which form the basis of the most important public health researches of the present day. The scheme which was presented to the Council in the early days of its work for the formation of these laboratories contemplated the creation of temporary laboratories, which should be put in working order and should demonstrate the nature of the work carried on in such laboratories, and its close and immediate connection with the interests of the health of man, and with investigations of high commercial value to every department of agriculture, and with the study of the costly epizootics which affect the prosperity of the grazing interest and influence of the food-supply of the nation. These laboratories have been in every sense successful. We have already noticed with satisfaction the paragraph in the report which the Council presented on the closing day of the Exhibition, in which they referred to a proposition that had been laid before them for establishing these health laboratories on a permanent footing as the best possible application of the surplus. The amount of that surplus has not yet been determined, and it is premature to speculate upon it. There is reason to fear that it will be much less than has been publicly rumoured. We have seen it anticipated in print that it will amount to nearly 30,000*l*. On the other hand, we have it on good authority that it is not likely to exceed half that sum. However this may be, it is satisfactory that the address, of which we print a part, and which has a semi-official value, coming from a member of the Executive Council, with the Chairman of the Council presiding, adverts to this application of the surplus almost as though it were a settled matter. Mr. Ernest Hart may of course speak with some excessive hope, inasmuch as it is known that the first establishment of these laboratories was due to his efforts, and they were formed upon the scheme which he drew up for the purpose. The proposition for making them permanent proceeds comes also from him, and no doubt he has a paternal hopefulness which may be excessive. There is, however, evident reason for accepting this most desirable application of the funds as the most probable issue, seeing that the Duke of Buckingham so heartily indorsed it in his speech at the Society of Arts at the close of the address, and that Sir Frederick Abel, also a member of the Exhibition Council, and not likely to speak with other than official caution, stated that Mr. Hart's scheme had now obtained,

he believed, a pretty unanimous consensus of opinion in the Council. Outside, opinion has at once declared itself with strong approval of this application of the funds, and it is indeed evident that, if the Council can succeed in establishing health laboratories which shall find for the health students of this country establishments properly equipped such as those of Pasteur, Koch, and Miquel, the Exhibition will not have lived its short life in vain, but will leave behind it an institution not only of permanent value but of growing importance and of large promise. The Commissioners of 1851 will certainly see with great satisfaction this liberal intention of the Executive Council of the Health Exhibition to add to those laboratories which they have already provided one which is so greatly needed to complete the means of study and of education which South Kensington supplies in other departments of technical and biological research and teaching. They will probably make no difficulty—or, rather, they will have the strongest reason which a desire for national usefulness will give them to overcome any difficulty—in providing a suitable site for such laboratories. Even if the means which the surplus may provide should not be adequate for the establishment and endowment of such a laboratory, there is little doubt that, with this good beginning, so much may be effected as will afford the best possible reason and the largest inducement to societies such as the Royal Society, the British Medical Association, the British Association, and others to make grants to students conducting research in the laboratories. The Government can hardly refuse to make grants in aid of an institution which in any other country than this would be wholly supported by State funds—witness the health laboratories of France and Germany, which are liberally maintained by State endowments. In this country, however, we are accustomed to look to private enterprise, and the liberality of societies or committees, to furnish at least a large part of the funds required for scientific research or endowment, and it is satisfactory to know that the Council of the International Health Exhibition have favourably considered the proposition that they should take the first step in this useful direction. Every one interested in the promotion of real health-progress will trust that it will soon be an accomplished fact.

THE BUTTERFLIES OF EUROPE

The Butterflies of Europe. Described and Figured by Henry C. Lang, M.D., F.L.S., &c. Pp. 396, Super-Royal 8vo, with 77 Chromo-lithographic Plates. 1881–1884 in parts. (London: L. Reeve and Co., 1884.)

FOR some years past the writer of this notice has, almost annually, formed one of the members of that large class of Englishmen who, each year, spend a few weeks in the Alpine and sub-Alpine districts of Europe for "relaxation." The writer prefers to leave it to the taste and fancy of the individuals interested to define the meaning of the latter term. He has naturally met hosts of "foreigners" of different nationalities engaged in the same pursuit. Whatever may be the state of the weather or other conditions incidental to travelling of this kind, those *voyageurs* of Gallic origin succeed in amusing themselves after their own special fashion. The Teutonic element also succeeds, but in an entirely different manner. The Americans seem tolerably successful. They leave home to "do" Europe, and they "do" it, in their own businesslike fashion,—business and pleasure are carried out on the same principles. Then there comes the large class of our own countrymen and countrywomen. We must confess that, according to our observation, the majority of these do not bear the outward appearance of enjoyment (especially the male portion). There is something apparently wanting. They have left their business or profession behind them, and the void thus occasioned cannot be satisfactorily filled in. From these must, of course, be separated those who find enjoyment in the excitement of Alpine climbing, and some others. Amongst these others are those who may be seen with *vasculum* at back, or insect-net in hand (very frequently in ill-disguised clerical garb), enjoying *themselves* to an extent unknown to, and often not understandable by, their fellow-countrymen who have voluntarily placed themselves under the same conditions. Probably a still larger amount of Teutons may be observed provided in the same way. And only this year we found ourselves seated next to a New England divine and his wife, and overheard the latter read out to her husband an advertisement of a butterfly-book, with the remark, "That would just suit *you*."

In the foregoing notes we have tried to draw a picture which we (perhaps we are prejudiced) believe to be tolerably natural. The pursuit of some branch of natural history studies on our travels adds a zest to the other conditions of surpassing value. If pursued systematically, it can hardly be termed "relaxation," if taken to mean "doing nothing." But if the work be harder (and it often is very much harder) than ordinary occupations, it is often the one thing needed, both for health and enjoyment.

Of the bearers of the insect-net in the Alps the majority occupy themselves with butterflies and moths, and the majority of these again with butterflies only. To an Englishman accustomed only to his own meagre, and declining, butterfly fauna, the wealth and beauty of forms is marvellous. With the exception of a small, but useful, manual, published by Mr. W. F. Kirby more than twenty years ago, and which consists almost entirely of laconic descriptions without figures, there has been, up till now, no work in the English language that enables collectors of European (as opposed to British) butterflies to name their captures without the troublesome comparison of some noted collection. These therefore will thank Dr. Lang for having supplied the deficiency, and in a generally satisfactory manner. The author has adopted no new system of his own. He follows Staudinger's German Catalogue, describing (for the most part originally) and figuring those species that occur in Europe proper, and simply describing those that have not occurred in "Europe," but still form part of the "European Fauna" (a term becoming daily more difficult to define). We think there is evidence of a little too much dry routine in the text: the descriptions appear to be excellent, and there is always a notice of the larvæ when known, and tolerably copious geographical information as to distribution, but the class of readers who will mainly use the book would be more readily caught by a mixture of

popular matter, recalling to their minds some of the scenes in connection with their own captures, or serving as a stimulant for future expeditions. But after all it is the *plates* that will be most frequently consulted. Of these there are seventy-seven, mostly crowded with figures, and including a few of transformations. Without the recent adaptation of chromo-lithography, in a superior form, to natural history subjects, the publication of such a work as this (at the price) would have been impossible. The author estimates that there are more than 800 figures on these plates. It is impossible here to criticise them *seriatim*. Those subjects that appear the most difficult are often the best (perhaps more detail in the way of "stones" was used on them), and we are much pleased with the *Hesperidæ*, which, easy as they may look at first sight, must prove very troublesome of application. The "Blues" and "Coppers" (*Lycænidæ*) are fair, but naturally fail in effect where metallic colours are necessary. The worst, to our mind, are those of the *Satyridæ* (of which our "meadow-brown" is a familiar example), and yet they *look* the easiest: we think here there is evidence of trying to make too many species, with varying shades of practically the same colour, accommodate themselves to one "stone." The size is rather too large for a book to be used as a travelling companion, but we think it is rather intended for home study. Paper and type are very good (the former almost unnecessarily so). There is not much to find fault with in the way of uncorrected errors. This is satisfactory, because careless correction is the crying evil of the present day, even in works claiming a much higher scientific position than does this, and often shows up the amount of knowledge possessed by writers of the authors and works they quote. But such glaring errors as the following should not have escaped correction:—Page 47, "Illus. Mag." for "Illiger's Mag."; p. 61 (and elsewhere), "Wein" for "Wien"; p. 153, "Sellmann's" for "Silliman's"; p. 380, "Thurnberg" for "Thunberg"; and, as a crowning morsel, p. 379, "Aumer Kungen" for "Anmerkungen." In notices of some of the recent additions from Central Asia, the author uses indiscriminately (sometimes on the same page) "Samarcand" and "Maracand" as localities; we thought it was generally understood that the latter is only the ancient name of the former.

We have hitherto dealt with this work from a popular point of view. But there is also the scientific side of the question. The book will be of service as collectively giving good descriptions and figures of all known European species brought down to date, and thus avert the necessity of search through a multitude of scattered publications; and in this it will be useful to other than English readers.

On the title-page the author adopts a super-title—"Rhopalocera Europæ." This we think a pity in a work otherwise entirely in the English language.

R. McLACHLAN

ELEMENTARY MATHEMATICS

Lehrbuch der Elementaren Mathematik. V. Schlegel. Pp. 712. (Wolfenbüttel, 1878-1880.)

WE have not had the good fortune to meet with this work, but having now before us an elaborate notice of it by M. Hoüel in the *Bulletin des Sciences Mathématiques et Astronomiques*, December, 1882 (pp. 301-313), we have thought that a few passages from the notice would be acceptable to some of our readers, and lead them to a personal examination of the original treatise.

The writer's opening remarks have much truth in them:—"Nous sommes habitués depuis longtemps à considérer l'apparition d'un traité élémentaire de mathématiques comme un événement pédagogique ou commercial n'ayant rien de commun avec la science pure. Si l'on met à part quelques honorables exceptions, c'est toujours le même livre qui reparaît sous une couverture de couleur différente, avec quelques pages transposées, quelques propositions secondaires introduites ou supprimées, quelques démonstrations modifiées sinon perfectionnées, quelques développements de plus suivant les tendances des programmes officiels. Quant à la manière d'exposer les principes fondamentaux de la science, rien n'est changé. Les découvertes qu'on a faites dans les hautes mathématiques depuis un siècle et qui ont si admirablement éclairci les difficultés que présentaient encore les éléments d'algèbre semblent étrangères à nos auteurs, qui expliquent les imaginaires comme au temps de Bézout et de Lacroix, et présentent parfois à leurs lecteurs des notions géométriques en arrière de beaucoup sur celles qu'exposait Euclide il y a plus de deux mille ans. . . . En Angleterre, l'enseignement est resté ce qu'il était au temps de Barrow et de Simpson; heureusement le vieil Euclide a été choisi et fidèlement conservé à l'abri des prétendus perfectionnements des traités modernes."

M. Victor Schlegel is a pupil of H. Grassmann, and his present work is inspired by the bold views of the author of the "Ausdehnungslehre." It consists of four volumes devoted to arithmetic, algebra, plane and solid geometry, and plane and spherical trigonometry. Vol. i., "Arithmetik und Combinatorik" (182 pp.), treats of elementary algebra and of the theory of combinations. "Le tout est exposé avec une concision qui n'exclut pas la clarté, et avec une rigueur irréprochable." The reviewer's attention is especially directed to an analysis of vol. ii., "la partie vraiment originale de l'ouvrage." In 222 pages are laid down the principles of plane geometry, the ideas in which are those first introduced, we believe, by Grassmann. A full statement is given of the fundamental hypotheses, and the treatise consists of two sections. The first, "Geometry of Figures in Motion," naturally discusses the geometry of the straight line and of the plane; the second, "Geometry of Figures at Rest." A collection of 737 exercises closes the book. The following remark by M. Hoüel is deserving of a place here:—"La tendance de la nouvelle école à remplacer le raisonnement par le coup d'œil nous semble éminemment dangeureuse. Le sentiment de la forme est un précieux auxiliaire, auquel les illustres inventeurs de la géométrie pure ont dû une grande partie de leurs découvertes: mais rien en mathématiques ne peut dispenser de la démonstration, d'autant plus que cette partie de la tâche est en général la plus aisée. Dans le cas actuel, la marche d'Euclide n'est pas plus longue, et ne laisse aucun doute dans l'esprit."

The third volume, Rectilineal (or Plane) Trigonometry, is founded, in like manner with the second, on a treatise on the subject published by Grassmann in 1865.

Approving in the main of this volume, we gather that the reviewer differs from the author on some points. M. Hoüel's views we have lately come across in "Rémarques sur l'enseignement de la Trigonométrie" (a paper originally printed in the *Giornale di Matematiche*, t. xiii., 1875, and reproduced in the *Mémoires de la Société des Sciences Physiques et Naturelles de Bordeaux*, 2e série, tome v., 1882, pp. 197-209). He altogether approves of M. Schlegel's appendix, containing a table of *rational* right- and oblique-angled triangles "où l'on puiser d'excellents exercices de calcul numériques."

The fourth volume, devoted to Solid Geometry, is prefaced by an introduction in which the author discusses the most convenient methods for getting clear ideas of figures in space, viz., by the use of models in relief and by stereoscopic images (at the end are plates, corresponding, we presume, to Clerk Maxwell's stereograms, of polyhedra).

"Un auteur se disposant à écrire un traité classique ne saurait trouver une meilleure préparation que la lecture du livre de M. Schlegel, où il apercevrait tant d'horizons nouveaux, inconnus à la routine, et qui eux-mêmes peuvent conduire à des découvertes ultérieuses."

We must not omit to state that M. Hoüel objects to some of the ideas put forward; but the grounds on which he commends the "Lehrbuch" (in addition to others adduced above) are thus summed up:—"Quoi qu'il en soit, nous sommes si peu accoutumés à rencontrer dans les manuels de géométrie des idées neuves et hardies, que nous n'hésitons pas à saluer comme un heureux événement dans la littérature géométrique l'apparition de ce traité, où le disciple fidèle de Grassmann s'est fait le sagace interprète des idées du maître sur l'enseignement élémentaire."

OUR BOOK SHELF

The Edible Mollusca of Great Britain and Ireland. With Recipes for Cooking Them. By M. S. Lovell. (London: L. Reeve and Co., 1884.)

We have received the second edition of this interesting, useful, and in some respects most amusing book. The primary object of the author is to call attention to the qualities and merits of many kinds of shell-fish which are as nutritious as others which are generally known, but which are rarely met with in our markets, or are only used locally for food, while the proper modes of cooking them are scarcely known. Accordingly all the known species of edible shell-fish on our coasts are here described in succession, with the various modes of cooking them. This alone would make the volume of great use at a time when we are going to the uttermost ends of the earth for the sources of our food-supply, and when public attention has been so powerfully drawn to our fisheries by the Exhibition of last year at Kensington. But when we add that the writer has collected from the most varying sources—from an "old M.S." to the Bridgewater Treatises, and from Athenæus to the latest book of travels that is having its little day,—a mass of curious lore about shell-fish, their uses, and the mode of catching them in various parts of the globe, their medicinal properties, the popular superstitions about them, &c., it will be perceived that this is much more than a work on natural history *plus* a cookery-book. If the title were not too suggestive of dulness for such an amusing volume, one would feel inclined to say that "Encyclopædia of the Edible Mollusks" would be a suitable title. And when we examine the formidable list of works "referred to or consulted" at the end, filling with mere titles thirteen pages, we cease to wonder at the out-of-the-way information contained in the volume. Of the nineteen sections in which the subject is treated, that on the *Ostreadæ* is, as might be expected, the longest, although that on the *Helicidæ*, which is also comparatively long, appears to us the most amusing. We hear of many infallible corn solvents, corn-destroyers, and the like, but the prescription of Master Ralph Blower, who wrote a certain "Rich Storehouse or Treasurie for the Diseased," possesses at least the merit of originality. Here it is. "Take black sope and snailes, of each a like quantitie, stampe them togither, and make plaister thereof, and spread it upon a piece of fine linnen cloth, or else upon a piece of white leather, and lay it upon the corne, and it will take it cleane away within seven dayes space." Master Blower who, by the way, wrote "for the benefit of the poorer sorts of people that are not of abilitie to goe to the Physicians," supplies the recipes for other cunning decoctions of snails, as do several other physicians who are quoted. Snail-water appears to have been considered a sovereign cure for consumption; but it may not be generally known that a large trade in snails is carried on for Covent Garden Market in the Lincolnshire Fens. They are sold at 6*d.* per quart, and it appears that they are still much used for consumptive patients and weakly children. Of all the many uses of snails in various parts of the globe, the strangest perhaps is that discovered by the London adulterator. They are much employed, the author assures us, in the manufacture of cream, being bruised in milk and boiled, and a *retired* milkman pronounced it the most successful imitation known! There are, we should say in conclusion, many beautifully coloured illustrations.

Forestry in the Mining Districts of the Ural Mountains in Eastern Russia. Compiled by John Croumbie Brown, LL.D., &c. (Edinburgh: Oliver and Boyd; London: Simpkin, Marshall, and Co., 1884.)

Still another book on forestry by Dr. Brown, uniform in size and binding with those that have preceded it. We have before alluded to the readable character of Dr. Brown's books, and the one before us is no exception to those on "The Forests of England" and the "French Forest Ordinance of 1669"; indeed it is perhaps more popular in its style, which Dr. Brown is not entirely responsible for, as he states on his title-page that it is a compilation, and the free use of inverted commas shows it to be so to a great extent. Though the book may contain a very good description of the country under consideration and accounts of the several journeys made in Russia, we are bound to say that not more than half deals with forestry matters. Thus we have one chapter devoted to the journey from St. Petersburg to Moscow, including a description of the Nijni Novgorod Fair. Another chapter describes the "Mishaps and Difficulties Experienced in Travelling"; another "Metallurgy"; and another "Depressed Condition of Mining, Smelting, and Manufacturing Establishments." The chapters that deal with forestry in some form or another are on "Forest Exploitation in the Government of Ufa"; "Abuses in Connection with the Exploitation of Forests"; a short one on "Forests," &c.

It may be stated that Dr. Brown's several works on "Forestal Literature" were awarded a silver medal at the recent Forestry Exhibition in Edinburgh, a fact to which he draws attention at the commencement of the present volume.

Die pyrenäische Halbinsel. Von Dr. Moritz Willkomm. II. Abteilung: "Spanien." (Leipzig: G. Freytag, 1884.)

This forms one of a series of volumes on the countries of the world, and appears to be part of a German "Universal-Bibliothek" entitled "Das Wissen der

Gegenwart." It is clearly printed, has numerous illustrations, and the information, which is excellently arranged, is brought down to the latest date and is very full. The volume and the series are of a kind more numerous and popular in Germany than in England.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Prime Meridian Conference

In *La Nature* of November 22 (p. 399) appears what is represented as information obtained at the meeting of the Academy of Sciences at Paris on November 17. It is stated that the proposal made by Prof. Janssen at the Meridian Congress at Washington, relative to the application of the decimal system to the measurement of angles and time, obtained a majority of 24 votes against 21, notwithstanding the "opposition *très-vive*" of the English and Americans. The vote to which reference is made was not on the merits of Prof. Janssen's proposal, but merely whether the opinion of the President that the Congress was not competent to entertain it, should be upheld or not. The decision being in favour of considering it, the proposal was accepted unanimously. On turning to the *Comptes Rendus* of the Academy I find it simply stated that M. Janssen observed that his proposition had been accepted almost unanimously, and without a vote in opposition.

La Nature further refers to the British delegates as having made the discussion on the prime meridian a question of "*amour-propre*," and as having converted to the British cause most of the representatives present. This statement is no less inaccurate and misleading than the former. As M. Janssen himself remarked at Washington, England did not make the proposal to adopt the meridian of Greenwich, and though the British delegates differed from their French colleagues as to the considerations which should govern the choice of a prime meridian for longitude, there was not a word said by them to justify what is stated by *La Nature*, and it is manifestly absurd to speak of the conversion of the representatives to the British cause, inasmuch as it is a perfectly well-known fact that almost every one of them came to Washington with instructions from their own Governments to vote for the Greenwich meridian. In justice to M. Janssen I wish to add that the *Comptes Rendus* makes no reference whatever to anything having been said by him on this subject.

It is greatly to be regretted that a journal professing to be scientific should have given a colour to the discussions which took place at Washington that forcibly suggests a deliberate intention of exciting national jealousies and animosities.

RICHARD STRACHEY,
Late Delegate at Washington

December 5

It is to be regretted that the French delegates have declined to accept some of the resolutions of the Prime Meridian Conference, but it is to be hoped that their non-adherence is only temporary; at the same time it must be admitted that their contention that Greenwich is not a scientific starting-point for a universal meridian has much to be said for it; the zero of longitude ought certainly to be defined somewhere on the equator, and if it were to be hereafter so defined at a point on the equator having the same meridian as the Greenwich instrument it is probable that all difficulty would be removed. The French are known to attach importance to ideas, and doubtless do not like the apparent supremacy which would be conferred on Greenwich if it were made the actual centre of departure. The point in question lies somewhere in the Atlantic Ocean, and is therefore on perfectly neutral territory.

One of the great obstacles to the introduction of the French metrical system into this country lies in the forbidding and inconvenient nomenclature attached to it. If the long compound names were translated into short English monosyllables, such as *met*, *kim*, *mim*, &c., not only would their use be greatly advanced and facilitated, but the French nation would in time borrow back from us our nomenclature. Such words offend at first sight by their new and startling aspect, but this all wears off in an hour or two; they require however to be started by some one in authority. There is a strange and unreasonable prejudice in the present day against the introduction of new monosyllabic words without derivation, which happily for us did not prevail in the days of our early forefathers.

It is desirable that at future meetings of the Conference the question of astronomical nomenclature should be considered; the practice of using the same names for sidereal and mean time is extremely inconvenient. I have suggested that the sidereal hour should be called a *sid*, or *sider*, and the second a *cron*, so that sidereal time would be indicated by the letters *s*, *m*, and *c*. Some such change is greatly needed, and new names should also be assigned to minutes and seconds of arc.

London, December 1 LATIMER CLARK

The Electric Light for Lighthouses and Ships

The application of the electric light to lighthouses and ships appears to me to be capable of considerable extension by a modification of the apparatus used. In lighthouses the practice is to have a fixed light in the lantern, with an apparatus either catoptric or dioptric, or a combination of both, for the purposes of bringing the rays of light from the arc into a parallel beam and sending them to the horizon. Sometimes, if not generally, this beam is cylindrical, and sweeps round at intervals of time as the combination of lenses and reflectors is rotated.

In the case of ships the head-light is an ordinary arc light, and searchers in use on men-of-war are arc lights set in the focus of a parabolic reflector, and pointed straight at the object it is wished to light up.

The arrangement that I would suggest as partly applicable to lighthouses and fully applicable to ships would be to use a fixed arc-light and large parabolic reflector in combination with a large, light, plane or suitably curved mirror to direct the beam of light, rendered parallel and cylindrical by the parabolic reflector, in any direction by means of this mirror only.

To apply this principle to a lighthouse, this light movable mirror would be placed in the lantern at an angle of something less than 45° with the vertical; the arc light and the fixed parabolic reflector would be placed below, centrally, in the tower; the light would then come from the parabolic reflector on the plane mirror, and so be sent in the required direction.

In using this mirror, where the light has to sweep over an angular area of less than 360°, I would use a to-and-fro motion, so that if the time of each sweep from side to side was 30 seconds of time, then any vessel in the middle line would have the light at this interval, but at any angular distance from the centre line the duration of the flashes would differ until, at the extreme range, two would be seen almost together, with almost 60 seconds interval between them and the next two, the sum of the time of two intervals always being the double of the fixed time for that light, and the difference between two intervals for all positions off the central line would enable the distance from the centre line to be determined by a vessel within the range of the light. An arrangement similar to this would answer for masthead lights for ships, the arc light and parabolic reflector being below deck, a light metal tube, terminating with a lantern to carry the plane mirror, going from the deck up to the required height in front of the foremast; the movement in azimuth of this mirror might be of the same kind as that mentioned for the lighthouse, but a much quicker motion from side to side, through 180° in about five seconds, would then give this time for all points in a straight line ahead, but vary at the sides in the manner already mentioned. As the light plane mirror has only to be moved, a clockwork arrangement would answer perfectly well for this purpose. In rough weather, when the vessel rolled, the light would have a tendency to vary too much in the vertical direction, but it would not be difficult to make the correction by a gravity counterpoise.

For war-ships such an arrangement, but on a more powerful

scale, would answer for a searcher, and the motions could be given by simple mechanical means or by means of electromotors worked from any point. Here the chief working parts of the apparatus would be fully protected, and this would be of the first importance, and the rapidity with which the light could be directed to any point or rendered quite invisible would be a great improvement on the present model, where all has to be exposed.

For forts requiring powerful searchers, and it is easy to see that they might be of great use here, this arrangement is suitable, particularly as the mark, being stationary, is more likely to be struck than in a ship; but the replacing of the plane mirror would be easily effected, and other part of the apparatus of course being quite protected, as in the case of ships.

In the case of a fort in a channel that it was desired to protect, the beam of light from a powerful fixed parabolic reflector could be so truly sent that it could be reflected from mirrors at a distance, as on the banks of the channel, so as to sweep across close above the level of the water and show the smallest object crossing the illuminated line.

It may be objected that in this second reflection there will be a loss of light, but that loss can be made very small, and there would be positive gain in using a large parabolic mirror in place of the necessarily small and imperfect ones in use in a lantern of a lighthouse or the deck of a vessel. Such a parabolic mirror could be made accurately in sections of very thin glass silvered at the back so as to retain its reflecting powers for an indefinite time; in the case of a lighthouse it might be placed at any point vertically below the lantern, even at the bottom if the tower had a well as large as the intended beam of light. The large mirror above may be also of thin glass silvered in a similar way and with such a slight curvature as might be required to enlarge the beam in any way, and more than one of these mirrors might be used if it was necessary to have a fixed light in one constant direction or for any other purpose. I am not sure if there would be any gain in the power to penetrate fog. In the case of a head-light, there would be certainly, from the collection of light into a beam instead of the naked arc; but whether a light such as the very small point that forms the arc including the incandescent carbon ceases to affect the eye in fog sooner than the same intrinsic light seen as a surface must only be settled by experiment on a proper scale.

Ealing, December 5 A. AINSLIE COMMON

Natural Science in Schools

IN the interesting discussion which has recently been carried on in your pages on the teaching of natural science in schools, not much has been said about the text-books which are, or should be, read. So long as the present system of teaching a single branch of natural science continues, and until the method recommended by Prof. Armstrong is adopted, it is clear that great care should be exercised in the choice of a good text-book on the particular subject selected. Even when it is found possible to teach science in the form of physiography, or *Naturkunde*, there will doubtless be many boys in the large schools who, having thus obtained a great amount of most valuable general knowledge and a wider view of the aims of science than is possible under the present system, will wish to carry on their studies in a particular direction. Taking chemistry, as the subject with which I am most familiar, and which at present is perhaps more widely taught than any other branch of science, it may be said that there should be no difficulty at all in selecting a suitable book. It is true that the number of text-book of chemistry is extremely large, and it is also true that there are a few books, written by men of wide knowledge and long experience in teaching, which are well adapted to the purpose in view. But it is, unfortunately, equally true that there are many text-books which are either untrustworthy or are badly arranged, or which contain little more than a bare collection of dry facts, and it is to be feared that some of these not unfrequently find their way into schools. Doubtless most teachers of chemistry will agree with Prof. Armstrong that the educational value of a course of instruction dealing merely with the methods of preparation and the properties of a number of elements and compounds is extremely small, because the faculty of reasoning from observation is not thereby developed. It will also, I think, be generally admitted that "it is of great importance that the meaning of the terms 'equivalent,' 'atomic weight,' 'molecular weight,' should be thoroughly grasped at an early stage." But it would perhaps be better that students should remain in complete ignorance of the meaning of these terms than that they should obtain such erroneous and illogical notions of atoms and molecules as are contained in some of the text-books. One of these books, which in 1880 had passed through no less than fifteen editions, and which appears therefore to be largely read, and which is advertised as being recommended by the head-masters of certain schools, contains the following remarkable statements:—

"Chemists *assume* that the elementary bodies are built up of infinitely small particles, which they call atoms; they further *assume* that these atoms, with few exceptions, are all of the same size. . . The exceptions are phosphorus and arsenic, whose atoms are believed to be half the usual size; and zinc, cadmium, and mercury, whose atoms are double the size." (The italics are the author's.) To the uninitiated it might appear strange to argue about the relative sizes of infinitely small particles.

Again:—"*All molecules are of the same size;* for the law of Ampère, which most chemists now accept, states that 'all gases and vapours contain the same number of molecules within the same volume.'"

Most of the errors contained in these statements are of course due to a misapprehension of the meaning of Avogadro's (Ampère's) law. It is not very easy to give an average student a clear conception of the fundamental generalisations and theories by means of which chemists have been able to determine the most probable relative atomic weights of the elements. To do this, it is first of all necessary to induce the student to think and reason for himself, and it seems to be much easier for most people to repeat a thing from memory than to understand it. But when the student's memory has already been stocked with such illogical statements as those quoted above, the difficulty is very greatly enhanced. SYDNEY YOUNG

University College, Bristol

The Edible Bird's-Nest

THE nature of the material from which the edible bird's-nest is formed has been long the subject of controversy. It is very gratifying to find from Mr. Layard's letter, published in last week's NATURE (p. 82), that a reconciliation of the various views is possible. Most writers support the theory that the substance is secreted in some way by the bird, though they differ as to the manner. Sir E. Horne, in a paper published in the *Phil. Trans.*, 1817, suggests certain gastric glands as the active ones. Bernstein, forty years later, points to the prominence in the nest-building season of certain salivary glands which form cushions by the sides of the bird's tongue, and suggests that these secrete the material. On the other hand, there are advocates of the view that the nest is constructed of certain vegetable matter found by the birds in the caves where the nests are built, and agglutinated by them by a buccal or salivary secretion.

Through the kindness of Prof Michael Foster I have been enabled to make some observations on the chemical nature of the material of the nests used for soup at the recent Health Exhibition, and from my experiments I have come to the conclusion that this is a substance resembling very closely the *mucin* described by Eichwald, Obolensky, and other writers, as forming the chief constituent of the mucous secretion of all animals and of the tissues of *Helix pomatia*, &c. It shows under the microscope scarcely any structure, but is laminated, shells splitting off easily in two directions. It contains here and there certain bodies resembling the cells of squamous epithelium. It is insoluble in either cold or warm water, but swells up in either, forming a gelatinous-looking mass; in both lime-water and baryta-water it is slowly dissolved, and the reactions of the solution differ very little from those described by the writers named as those of mucin. It resembles this body also in its behaviour when heated with acids, alkalies, and the different digestive ferments. The solution in lime-water contained a little debris, which proved to consist largely of pieces of feathers, with a little adherent amorphous matter. With the exception of certain microscopic particles among this, I could not get any evidence of the presence of vegetable matter in the nest substance. Indeed all the experiments I have described point certainly to the absence of anything but a glandular secretion.

JOS. R. GREEN

Physiological Laboratory, Cambridge, December 1

The so-called South Plant of Egyptian Art

THE identification of the original source of any conventionalised artistic form is always, I think, worth notice. It will probably interest many readers of NATURE to draw their attention to a short but instructive piece of work of this kind which Prof. Julius Lange has communicated to the Royal Academy of Copenhagen (*Bull.*, 1884, pp. 109-114). I am indebted to Mr. Liden, one of our garden staff at Kew, for a translation of the paper from the original Danish. I have freely condensed the details.

There is a well-known Egyptian symbol which represents both Northern and Southern Egypt. The northern symbol is admitted to represent the stem and head of the Papyrus. But the southern symbol has not hitherto been identified with any certainty. It has a lily-like form, and has been generally referred to the Lotus (*Nymphæa*), an identification which Prof. Lange thinks quite inadmissible, as the conventionalised treatment of this plant in Egyptian art is quite different.

The twin-symbol combining in a kind of knot the north and south plants is commonly found inscribed on the thrones of statues of Egyptian kings. In the later examples the south plant has the form of a flower with three divisions of the perianth depicted (implying that it was either five- or six-parted), and a definite flower-stalk. In one case Prof. Lange met with an example where the flower was separated from its stalk by some transverse carved lines.

Prof. Lange has, however, recently examined a diorite statue of King Chefren, which gives the symbol in a more primitive form. He finds that the supposed flower passes imperceptibly into the stalk, and that the apparent perianth segments are really distinct parts which are tied together by indications of ligatures. Without then arriving at any definite conclusion, he is content to point out the resemblance of the south symbol in this form to the palm-capitals of the Ptolemaic period. In these the leaves of the date are disposed round the body of the capital, and the junction of this with the column is indicated by transverse bands, the conventional representations of the ligatures which would hold the leaves together and in their places. As the date, according to Alphonse de Candolle ("L'Origine des Plantes cultivées," p. 240) has existed from prehistoric times in the dry and hot zone from Senegal to the basin of the Indus, between lat. 15° and 30°, a more characteristic plant as the symbol of Southern Egypt can hardly have been pitched upon.

W. T. THISELTON DYER

Earthworms

I SEE, in your issue of October 9 (vol. xxx. p. 570), an interesting communication entitled "A Gigantic Earthworm," in which the writer refers to worms of large size being fairly common in parts of Cape Colony. I may mention that here in Ceylon it is not an infrequent sight to see two or three of these big worms in the same day, after showers, though I would not pronounce them to be exactly common. I have seen some fully four feet in length, and about the thickness of one's little finger. They are of a pale slaty-bluish colour, and appear, on close examination, to have faint prismatic colours over parts of the body. These worms are seemingly not confined to particular soils or altitudes, as I have met with them at elevations of from 2000 to 4000 feet above the sea. Owing to their seeming inertness of body, the *lob-worms*—as I have frequently heard them called—soon fall an easy prey to swarms of small red and black ants, that attack the victim as it lies on the ground.

Passing from large to small, I may mention a curious earthworm that I found to be very common in North Borneo. The chief peculiarity about this worm is the size of its "cast," this being about four inches high by one inch and a half across the top, which is made cup-shaped or with a marked depression, for the purpose, I believe, of catching water. The stem—if I may apply the word—of the "cast" is about an inch in diameter, strongly built of rows of earthy matter laid circumferentially, widening towards the top into a lip that forms the side of the cup. Sometimes a leaf may have fallen on the "cast" in the course of erection, and this is at once built over, so that part of the "cast" may be seen above and part below. The worm itself is very small, and hard to secure. I have found the only method of catching them was to suddenly break off a fresh "cast," when one could get a glance of the worm as it rapidly withdrew into the ground. It is of a fleshy red colour, and about the thickness of the stem of a crow-quill pen, but I do not know how long, as I never succeeded in extracting a whole worm from its burrow. The "casts" are very numerous, and weigh, I should think, quite an ounce each, and are to be met with both in the forest—as well as in gardens—and cultivated land. I also found them close to the banks of rivers that were sufficiently near the sea to be considerably impregnated with salt, so that I conclude from this that salt water is not destructive, at least to this species.

FREDERICK LEWIS

Bogawantalawa, Ceylon, November 5

Injuries caused by Lightning in Africa

IT is a remarkable fact that in all the publications relating to Africa we so seldom come across accounts of injuries caused by lightning. Some travellers—those of the German Loango Expedition of 1873-76 for example—even distinctly report that, notwithstanding the extreme frequency of lightning in Africa, cases of damage inflicted by it are almost unheard of. During my own stay on the Congo, though I was eagerly on the look-out for instances of this kind, I did not succeed in authenticating a single case of injury due to the electric fluid. There was indeed a vague rumour among the natives of a man in some village having been struck dead and a "tshimbek" burnt down by lightning, but I could find no eye-witnesses of the fact; and all the time I was in Africa I never saw a tree or other object which showed any signs of having been struck by lightning. The only case of which I obtained any authentic report was that the coal-magazine of the French factory at Banana was burnt down in consequence of a lightning-stroke in March 1882. I have been recently informed, however, that just a year after the destruction of the French coal-magazine, the large gin-store of the Dutch factory at Banana was similarly destroyed, a flash of lightning having kindled a great fire there which lasted four days. As a result of these two accidents following so close on one another in the same locality, lightning-conductors are now being set up at Banana, and the International Association of the Congo has had conductors fixed on all the magazines at Vivi.

I find in Dr. Pogge's journals, which I am now preparing for publication, an instance, witnessed by that traveller himself, of a man being killed by lightning. As far as my own researches go, I find scarcely any literature concerning the use of lightning-rods or the frequency of accidents from lightning in the tropics: and if any of your readers would communicate to the columns of NATURE any information relating to this subject which they may have gained by a residence in those regions, they would render a great service to meteorological science.

Hamburg, November 29 VON DANCKELMAN

The Northernmost Extremity of Europe

YOUR correspondent, Mr. Mattieu Williams, says, on p. 54 that Tonsberg "is admitted by all as a high authority" on Norway. May I be permitted to ask who these "*all*" are? I knew this gentleman very well, and he never claimed the least *geographical* authority for a faulty and crude "Guide for Tourists," which is all that his work is. I beg to refer your correspondent to the preface, where the author himself says that, for reasons explained, it has many faults. To set Tonsberg up as a *geographical* authority would indeed be an insult to Norwegian geographers. Your correspondent further says that he saw with his own eyes, ten years ago, that Knivskjærodden jutted further north than the North Cape. Had I happened to meet him before he started on his excursion, I, then but a school-boy, could have informed him of this startling fact. What I said was, that we had assumed it, but it had only been *proved* by measurements this summer. That was all. As regards the *height* of the promontories on the coast of Arctic Norway, I am sorry to have to repeat my contradiction that there is no single one which is higher than the North Cape. Your correspondent again quotes Tönsberg. If quoting this "high authority" at all, the statement should be correct. Your readers are informed that this guide-book says that Sværholtklubben "is *twenty-four* Norwegian (why *Norsk*? if Norwegian it should be *Norske*) feet higher than the North Cape." Tönsberg says nothing of the kind. What he says is simply that it is *upwards of* (*henved*) 1000 feet, and from this vague guess your correspondent evolves a fresh discovery and figures. Had he taken the trouble to consult the poorest of our geographies, he would have learned that the North Cape is *indisputably* the highest headland in Finmarken. His concluding statement that there are a dozen others is merely an imaginative one.

As a foreigner, I cannot refrain from remarking that it seems strange to me that, because a man has paid a few weeks' visit to Norway, and even "halted in front of the North Cape for half an hour," he can claim to have become an authority on all scientific and other matters connected with that country among a nation which can boast of such distinguished explorers and *savants* as the English. A NORWEGIAN

The Scandinavian Club

Our Future Clocks and Watches

IN connection with the indication of universal time by our future timepieces, I venture to suggest that the hours should be contained in one circle; but, instead of being numbered consecutively from 1 to 24, they might be arranged in Roman numerals, as at present, and if figured alternately would be almost, if not quite, as distinct as on the faces of our present style of clocks. Thus, the hours 2, 4, 6, &c., would be shown in figures, but the intermediate or odd hours, as 11, 13, 15, &c., would be more advantageously distinguished by an arrow-head or circular dot.

As regards the striking of the hours by our public and private clocks, they might strike up to twelve, as at present; the suggestion of your correspondent "R. B." (NATURE, vol. xxxi. p. 80), that they should not strike any number above six, appears to me as objectionable as if they struck up to twenty-four; but to distinguish between the afternoon and morning hours, the hours from thirteen to twenty-four might be distinguished by being preceded by two strokes in rapid succession either upon the bell which strikes the hours, or, preferably, upon a bell of a different tone. B. J. HOPKINS

Leyton, Essex

Singular Optical Phenomenon

ON the night of November 28, at about six in the evening, I went to the window to look at the moon, and saw, as it were, a *second* moon behind the other. The effect was so like what one sometimes experiences from suddenly going out of a very light room, or other causes, that at the time I fancied it was only a defect in my sight. On going into my son's room an hour afterwards he said: "If something is not gone wrong with my eyes, there are two moons out to night." On this I went out again, but saw only the one moon as usual. Later in the evening a young girl who had been meeting a friend at the Montreux train, said her friend had said the moon looked *queer* all the while she was in the train. The night previous a pretty severe shock of earthquake occurred in Geneva and Lausanne, and a few hours after we had observed the moon on the 28th, a very violent gale and snowstorm took place, and lasted for about six or eight hours. I am not scientific enough to know whether the "rosy glow," reported on November 28 by Mr. Leslie of Southampton, can have any connection with this, or whether my letter will interest your readers. X.

Vevey, Canton de Vaud, December 6

The Aurora Borealis

WITH the view of making the Norwegian catalogue of the aurora borealis, at which I am now working, as complete as possible, I take the liberty of asking meteorological societies which are in possession of journals supplied by those who have navigated *Norwegian waters*, to be good enough to place within my reach a copy of the observations which these journals contain respecting the aurora borealis seen near *the coasts of Norway or in their neighbourhood*. I should also be equally grateful for all information with regard to other unpublished observations of auroras of Norway, which may perhaps be found in the archives of meteorological institutes. SOPHUS TROMHOLT

The Meteorological Institute of Christiania, November 19

THE UNITED STATES FISH COMMISSION

IN the year 1871 the Congress of the United States had its attention directed to the alarming decrease in the abundance of its east coast food fishes, and appointed a Commission to investigate the matter, with the idea of preventing the decrease. Prof. Spencer F. Baird, then Assistant Secretary of the Smithsonian Institution, was appointed at the head of this Commission, and in the early summer of 1871, with a small but efficient corps of naturalists, he established himself upon the southern coast of New England at a place called Wood's Holl. Among the most noted of the members of that party were A. E. Verrill, S. J. Smith, and Sanderson Smith, all of whom have remained with the Commission every summer since its foundation. The first work of the Commission was to investigate the fauna, which then was comparatively unknown to science. In this way the food-supply of the food fishes and the food fishes near shore were carefully studied. During this one summer the fauna of this region was so carefully studied specifically that few new species have since been discovered. The main results were set forth in a very extensive report upon the invertebrate animals of Vineyard Sound by Profs. Verrill and Smith, and published in the first Fish Commission Report. In the summer of 1872 Eastport, Maine, was chosen as the station, and here the same systematic study was carried on with the addition of some dredging work done in shallow water with small boats. The summer of 1873 was spent at Portland, Maine; 1874 at Noank, Conn.; 1875 at Wood's Holl again; and 1876 being Centennial year, there was no summer station, but the energies of the Commission were exerted upon the Centennial Exhibition at Philadelphia. In 1877 a part of the year was spent at Halifax, Nova Scotia, arranging a fisheries treaty, and the remainder at Salem, Mass. The head-quarters for the summer of 1878 were at Gloucester, Mass. Up to this time, and, in fact, until 1880, the Fish Commission had carried on all its off-shore work in steamers placed at its disposal through the courtesy of the Coast Survey and Navy Department, but had owned no boat of its own with the exception of small sailing-boats and a steam-launch in which the shore work could be done. Thus under a decided disadvantage, it would hardly be expected that a great amount of work could be carefully done; but, notwithstanding this, a large part of the Gulf of Maine was very carefully explored, under the direction of the Fish Commission. During the years 1878 and 1879 the fishermen of Gloucester very materially aided the Commission in its work of investigating the fauna of the shallower water of New England by preserving such specimens of animals as they happened to meet on their fishing trips. Scores of animals new to the American waters were taken from the fishing-banks by these fishermen, and the importance of their work should not be under-estimated.

As yet the Fish Commission had done little practical work in its marine departments. It was for practical work that the Commission was established, and all its scientific work had some practical object in view. In the winter of 1878 and 1879 the Commission began important experiments upon the hatching of deep-water fish, but more especially cod. When America was first discovered, cod were found on all its shores in great abundance, and from this abundance the headland of Cape Cod received its name. As white men became more numerous on the shore and cities began to grow, the fish began gradually to decrease in number and be driven off into deep water because of the impure condition of the water. Now, in places where fifty years ago cod could be caught from any point of rocks, it is a rare thing indeed to catch this fish within several miles of shore. Men, who not many years ago could anchor a boat within a few rods of shore and catch fish in large quantities, are now obliged to visit the more remote ledges several miles from shore, and be satisfied with a light catch. Even in the deep water they are becoming scarcer. It was with the hopes of finding some remedy for this decrease that in 1878 and 1879 Prof. Baird began experiments upon artificially hatching these fish. Millions of eggs are laid where few come to maturity, the larger part being destroyed before they are hatched from the egg. Thus, if the eggs could be hatched and the

young placed in the water only when they are old enough to partially take care of themselves, the proportion that would arrive at maturity would be vastly increased. By constant work at hatching these fish it was thought that much practical good might result. Many difficulties stood in the way, the most important being that the eggs floated and clogged the overflow screen. After much experimenting this was overcome. It was found, however, that the place chosen, Gloucester, was by no means fitted for the work because of impure water and extreme cold; but the object of the present work was merely experimental, and it mattered little whether the fish which were hatched lived after being placed in the water. Several millions of young cod were thus successfully hatched and placed in the waters of Gloucester Harbour, but, because of the impurity of these waters, it was hardly expected that the fish would be heard of again. But early in the spring of 1882 reports began to be circulated that young codfish of the deep-sea species (*Gadus morrhua*) were abundant in Gloucester Harbour. Subsequent investigation proved this report to be true. Since the cod first left our coast they have not been found in the Massachusetts harbours in any abundance, but at this time, even in the impure docks of Gloucester Harbour, it was not infrequent for boys fishing for perch and flounders to catch young cod. Several generations were distinguishable, and as there is but one other place where a similar abundance is reported, there is every reason to believe that they are Fish Commission cod, and that the other school is but an offshoot of the original group which was placed in Gloucester Harbour. It is, of course, expected that they will migrate, in time, to purer, cooler waters outside. There are fishermen now who are making good catches of these cod in the harbour itself—a thing unprecedented in late years. Thus the experiments, though primarily successful, have met with an additional success which was not in the least expected. Gloucester not being naturally suited for hatching cod, the Commission has begun the building of extensive hatching-houses at Wood's Holl, where in a few years artificial hatching of deep-sea fish will be carried on extensively. While at Gloucester the members of the Commission made extensive inquiries into the statistics of American fisheries, and complete reports upon the results have been published in the Fish Commission publications.

The summer of 1879 was spent at another large fishing port, Provincetown, Mass., where additional studies of the fishing apparatus were carried on. In 1880 the Commission was at Newport, Rhode Island; 1881, 1882, 1883, and 1884 were spent at Wood's Holl, Mass., which has been chosen as the permanent summer station of the Commission, because of the many natural advantages offered by the location. At present extensive buildings are in progress at this station. A large hotel for the use of the Fish Commission *employés* is already built, and was for the first time occupied during the past summer. On one side of this hotel the new laboratory and hatching-station is being built. It will be a very large affair, the lower story being intended for use as a hatching-room, the upper for a laboratory in which the scientific work will be done. In the cellar there are some large stone-walled tanks which will have direct connection with the outside water. A steam pumping-station will supply water to the aquaria and hatching-tanks. In front of these buildings is a large breakwater wall which will serve the purpose of a wharf for the larger vessels, and will also form a harbour for the smaller boats. It is expected that actual operations in fish-hatching at this station will begin in the spring of 1886, and that after that time each year millions of young fish will be sent out from the station to all parts of the New England coast and placed in the water to take care of themselves. It is hoped by these means to at least make an appreciable difference in the number of cod after years of work, and in part make up for the decrease. In the laboratory not only the regular *employés* of the Fish Commission will be allowed to work, but in the future a limited number of general students will be admitted to a table in the laboratory. By special arrangement with several of the leading American colleges, two students from each will be allowed to work each year in the new laboratory. This will be a chance that will be eagerly sought after because of the great advantages for study offered at the station. Under these improved advantages, it is expected that much better work will be done in the future than has been done in the past, when all the work had to be carried on in an old shed-like building poorly fitted for the work.

In 1880 an appropriation was obtained from Congress for the purpose of building a steamer, which was to serve as a floating shad-hatching station to work in the Chesapeake. This was the first large steamer owned by the Commission, and was named the *Fish-Hawk*. Although intended for shad-hatching, at the end of each shad-hatching season she proceeded to the summer station to engage in dredging. On account of her shallow build she was not fitted for dredging, and the Fish Commission was greatly inconvenienced while she was used for this purpose. The remarkable results obtained by this steamer on the Gulf Stream slopes have long since become known to the scientific world. Several hundred species were found which were new to American waters.

It was not long before the Fish Commission became convinced of the necessity of having a new steamer in which they could go to sea at any time, and one which was perfectly adapted for deep-sea dredging. Accordingly, in 1883, the *Albatross*, a 1000-ton iron steamer, 234 feet long and drawing 12 feet of water, was launched and immediately began work. That she is very nearly perfect in all respects, both in build and outfit, has been proved by her two years of nearly steady work. She is without doubt the most perfect dredging-steamer ever owned by any Government, and she is achieving the most remarkable results.

In the spring of 1879 a new fish, the tile-fish (*Lopholatilus chamælionticeps*), was found in abundance in the deep water south of New England, which promised to become an addition to our east coast food-supply. It was abundant and had a fine flavour. In the early spring of 1882 it was found dead in immense numbers on the surface just above the places where it was found in such abundance. In the official report it is estimated that there were at least 71,936,000 dead fish, of an average weight of ten pounds each, in an area of 5620 square statute miles. This estimate was arrived at by taking the largest trustworthy report of the numbers of dead fish given by the numerous captains and dividing it by 400, thus allowing that there was only one fish where 400 were reported to be. This wholesale destruction attracted much attention at the time, and the Fish Commission has since made a careful study of the subject, and although many trials have been made, not a single tile-fish has ever been taken. A few other species of animals have also disappeared from the same bank, and it is the theory that a cold wave of water from the inlying shallower region was driven across the warm bank inhabited by these fish by the strong northerly winds which prevailed at the time. The tile-fish being naturally a delicate fish, was killed by this sudden change of temperature, while less delicate animals survived. Whether they are entirely extinct or not cannot be told. Certain it is that, although many expeditions have been sent out and days spent in search of this fish, not a single specimen has been taken since that great mass of dead fish were found covering an immense area off the American shore. It is by far the most interesting problem as yet studied by the Fish Commission. An interesting history of this fish is given by Captain Collins in the Annual Report of the U.S. Commissioner of Fish and Fisheries for 1882, pp. 237-292, with a figure of the

fish and a map showing the position of the banks and the area covered by the dead fish.

In addition to this branch of the Fish Commission's work, it has been doing a very important service to the country by hatching shad and salmon, and partially re-stocking rivers with these fish. By introducing the German carp to America a work of great economic importance was achieved, and the large number of carp-ponds in America shows the popularity of this new fish. In connection with State Fish Commissions much work is being done, which is of great importance. In every State of the Union there is now a more or less important State Fish Commission, and nearly all have been started since the National Commission, which may be considered to be the father of them all. For several years naturalists of the Fish Commission have been studying the oyster problem, with the hope of in some way protecting them from their natural enemies and preventing their decrease. Under the direction of Mr. J. A. Ryder important experiments upon artificial oyster-farming have attained a marked degree of success, and within a comparatively few years it may be expected that oyster-culture in America will be revolutionised. There are at present experiments in progress upon the transplantation of certain desirable shell-fish from the east coast to the west coast of America. Owing to the extreme difference in character between the water of the two coasts, it is doubtful if these experiments will succeed.

For the purpose of studying the economic problems it is necessary that men be sent to different parts of the American coast, and these men are always instructed to study the fauna and make collections. These collections are all, after careful study by the Fish Commission naturalists, turned over to the United States National Museum, and in this way her zoological collections are vastly increased. The collections made by the Fish Commission steamers are of vast scientific importance, and they greatly add to the interest and value of the zoological branch of the National Museum collection. It is also the plan of the Fish Commission to distribute sets of duplicates from their collections to the different Museums of the country. Nearly 200 such sets have already been distributed, and special sets are made up for exchange with foreign Museums. It has been the policy of the Commission to carefully study American fisheries and the apparatus in use both in this country and abroad, and by this means find out the most improved apparatus and have it adopted in America. It was with this object in view that complete sets of American apparatus were sent to the Exhibitions held at Berlin and London, and that experts were sent to study the foreign exhibits. Already the effects of these studies are being felt in America, and American fishermen, having learned in the past to respect the Commission's advice, are beginning to adopt needed reforms in vessels and outfit. It is hoped that the American exhibits had some similar effect upon the fisheries of other nations.

The Fish Commission's work in its original conception was really the solution of practical economic problems, and it has in the main adhered to this idea. Hence its scientific work has been mainly upon animals which are in some way connected with such problems, the work in very deep-sea dredging being an exceptional but natural deviation from the rather uninteresting study of the shallow fishing-grounds to the rich field of deep-sea research. As this work can be carried on in addition to and without interfering with the regular work of the Commission, there is no chance for complaint. To the scientific world it is very important that this is the case. Dealing with the problems that it has, the natural history work of the Fish Commission has, of necessity, been mainly of a systematic character, dealing with species and their distribution more than with problems of anatomy, embryology, and histology. But there has been also much embryological work, that of Mr. Ryder upon certain economic fish and the oyster being of most importance. In addition to this natural history work, there has been the gathering together of complete collections of all apparatus used in connection with the fisheries, which have been placed in the National Museum. At some future time they will possess an immense scientific value.

The scientific and important practical results of the Commission's work are mainly set forth in the publications of the Fish Commission or the National Museum, but some of the monographs, and also synopses of species, which require better plates than the Government publications ordinarily contain, or need to be published in haste, are printed in some other publications. The Commission publishes an Annual Bulletin and an Annual Report. The former is printed in parts, a few pages at a time, and sent to scientific men as soon as published, and afterwards gathered into volumes. Four have been printed up to date, and they contain miscellaneous articles, many of considerable scientific importance. The Report is published annually, and contains the larger reports upon different questions and general monographs of groups of animals. There are nine volumes already published, and they cover the years of the Commission's work up to 1881. Many of the reports contain articles of great importance to the scientific world.

RALPH S. TARR

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND

A GREAT amount of valuable scientific work, of a special character, is done by the various engineering institutions of the country; and much of the progress latterly made in the practical applications of science to mechanical operations, and also in the advancement of those sciences which bear most directly upon engineering work, is largely due to the growth of these institutions. The principal one—that of the Institution of Civil Engineers—may be regarded as the parent institution, not only by reason of its age, but also because of its high standing and the quality of its work. The Institution of Civil Engineers has contributed, in a very important degree, towards transforming engineering from the position of a "base mechanical" calling into one which ranks high among learned and scientific professions.

The great success and usefulness of the Institution of Civil Engineers has gradually led to its work becoming more and more differentiated, and to certain special branches of it being taken up by other institutions that have been formed for the purpose. We thus find the Institutions of Mechanical Engineers, Telegraph Engineers, Naval Architects (in which marine engineers are included), the Iron and Steel Institute, and others. All of these institutions are in a prosperous condition, and enrol a large number of new members every year. They have been most successful, without exception, both professionally and scientifically. While, on the one hand, they have benefited their members by collecting papers and providing opportunities of discussion upon points of vital interest to them in the pursuit of their various callings, they have also, on the other hand, carried scientific investigation forward in directions which would otherwise have been much neglected. The field of science—and particularly the inductive side of it—has been greatly extended by the able and thorough—though often unobtrusive—work which has been done by the engineering institutions.

It is not in the metropolis alone, however, that such institutions are now to be found. They supply too universal a want to admit of being centred in any one part of the country. We have just received from Glasgow the twenty-seventh annual volume of the *Transactions* of a well-known and excellent institution which exists in that city, viz. that of the Engineers and Shipbuilders in

Scotland. This Institution is not restricted to the marine or any other special branch of engineering, but includes among its members civil and mechanical engineers of all classes, metallurgists, marine engineers, and shipbuilders. Its published volumes of *Transactions* usually contain papers of a varied and instructive character, and very valuable communications from some of the most eminent Clyde engineers are to be found in them. The importance of this Institution may be judged of by the fact that the number of its members, associates, and graduates amounts to 581.

The volume of *Transactions* just issued contains papers and discussions upon the properties of the compound engine, the stability of ships, screw piles, the testing of turbines, cable tramways, and other subjects. There is also a Presidential Address, delivered by the President, Mr. James Reid, of the Springburn Locomotive Works. Mr. Reid reviews briefly many of the latest engineering achievements that have been recorded, or that are being attempted. He refers to railway operations in this country and abroad, tramways, steam-shipping, docks, harbours, canals, bridges, hydraulic and electrical machinery, gas, and smoke combustion. Where the range of subjects is so varied and extensive, the briefest references are usually of course all that are possible.

Mr. Reid points out, with regard to railway traffic, the beneficial results of lower fares and other increased facilities in not only wonderfully augmenting the volume of third-class traffic, but also in adding, upon the whole, to the receipts of the railway companies. "As the downward movement of classes is still continuing, the outcome will most likely be a general reduction of the number of classes to two—nominally first and third, but practically first and second." The railway companies in this country yet have a most useful work to do in circulating food-supplies. The Fish League have had refrigerator cars constructed, which are working between the Scotch ports and London; and this small commencement is capable of a very large and urgently-needed development. A new departure in locomotive practice has been taken by M. Anatole Mallet in France, and by Mr. F. W. Webb in England, by compounding the engines. The results thus obtained are stated to be very satisfactory, although the maximum economy that is practically possible can of course only be obtained by steam-jacketing the cylinder, or by the use of superheated steam.

The advances that have recently been made in steam-shipping are referred to. The fastest voyage made by any steamer prior to October 23, 1883, was that of the *Alaska*, in which she ran 2784 miles, between Queenstown and New York, in 6 days, 21 hours, and 40 minutes. Mr. Reid says that this is equivalent to a mean speed of 17 miles per hour; but he speaks of miles in connection with these figures as though he were dealing with ordinary statute miles. The figures given really relate, however, to knots, or nautical miles, so that the speed of the *Alaska* upon the voyage in question was at the rate of over 19½ miles per hour. Mr. Reid also says that at an average speed of 19¼ miles per hour the Atlantic might be traversed in six days. The average speed requisite for crossing the Atlantic in six days is about 19⅓ knots, or 22½ miles, per hour, a speed which nearly amounts to that of many ordinary railway trains.

The performance of the *Alaska*, which Mr. Reid refers to, has been much exceeded during the present year by two Atlantic liners, the *Oregon* and the *America*. The *Oregon* has crossed the Atlantic in less than 6 days, 10 hours, thus beating the *Alaska* by nearly half a day. The *Umbria* and *Etruria*, the new vessels of the Cunard Company, are expected to beat the *Oregon* by about as much as the latter beat the *Alaska*. The *Umbria* is said to have attained, upon the measured mile, a mean speed of 20½ knots, or nearly 24 miles per hour. It is possible that she may succeed in crossing the Atlantic in six days.

Passing from the wonderful strides thus making in steam-shipping, the President calls attention to the chief of the large canal schemes which are now before the world, such as the Panama Canal—which the indomitable energy of M. de Lesseps appears likely to bring to successful completion—an independent canal across the Isthmus of Suez, and the Manchester Ship Canal. It is surprising, however, that, while referring to these various means for facilitating transit across the ocean, and also to the Channel Tunnel, Mr. Reid omits to notice the ship-railway scheme of the American engineer, Capt. J. B. Eads, C.E., which has now been for some time before the engineering world, and has received the approval of some of the most eminent authorities.

The principal papers contained in the volume of *Transactions* under notice are those upon the compound engine viewed in its economical aspect, by Mr. R. L. Weighton; upon the stability of ships at launching, by Mr. J. H. Biles; and on approximation to curves of stability from data for known ships, by Messrs. F. P. Purvis and B. Kindermann. Mr. Weighton's paper gives a clear and able explanation of some of those properties of the compound engine which affect its economical working; and while there is nothing novel or recondite in it, and it is somewhat amateurish in style, it is of value in keeping before the minds of engineers points of fundamental importance which it is well for them to think precisely and frequently about; and it did good service in causing one of the longest and most interesting discussions which took place during last year's meetings. We dissent entirely from an opinion expressed by one of the speakers, that "papers brought before an Institution of this kind should either expound some new theory, contain some novelty, or bring before them some important addition to the mechanical details of any machine." An exclusive striving after mere originality is not an unmixed good; besides which, one of the greatest advantages of such institutions as that of the Engineers and Shipbuilders in Scotland is that the members become familiarised by papers and discussions which are even of a commonplace type with what is already known and thought by the most capable men upon subjects that all engineers require to thoroughly master. It is not novel points nor original conceptions only which are of value to the rank and file of members; a still more potent cause of good is to be found in the educating and informing influence which is exerted by well-established scientific ideas and recorded experience being frequently discussed, and by the constant and ready reference to fundamental and accepted principles which this involves.

The paper on the stability of ships at launching is accompanied by curves for various types of steamer at launching-draught, and advocates constructing such curves, as a rule, before launching ships. It is well worth reading, as it, and the discussion upon it, show how diverse and inconsistent though, on the whole, vague are the views held by many shipbuilders, both upon the necessity for ascertaining the precise degree of stability possessed by a ship, and also as to the sufficiency of a given amount of stability for purposes of safety. The author is somewhat ambiguous and inaccurate in his definitions of such terms as "stability," "stiffness," &c., and inconsistent and loose in his use of them: but this appears to be a common fault with technical writers upon naval architecture, as was pointed out by Prof. Osborne Reynolds at the British Association meetings of last year. For instance it is stated in the paper under consideration that "the kind of stability which is required at launching is stiffness," and "the question of stability at launching appears therefore to reduce itself to one of stiffness,"—stiffness being represented by the metacentric height, which measures the force required to incline a given vessel through small angles from a position of rest in still water. Yet the author goes on to say that "our only safe guide is the

complete investigation of the stability of a ship at angles considerably beyond those to which the metacentric height is a fair measure of the stiffness." He also speaks of the "stability of a ship up to 60° of inclination." This is a strange although common misuse of the term "stability." Stability only exists at a position of stable equilibrium, and what is really meant by the above-quoted sentence is not stability at large angles of inclination, but *righting force*.

The other paper upon stability, which describes a method of approximation to curves of stability from data for known ships, is interesting in showing how some of the elements of stability vary in a ship with the ratios of draught of water to depth, and depth to breadth; but we cannot regard it as likely to be of much value in practice. The approximations obtained by applying the method are only reliable when the form of the vessel for which the curve of stability is required, and that of the one which is being used for estimating it from, are so related to each other that any section of the one may be obtained by projection from the corresponding one of the other. Differences in form are excessively numerous—almost universal indeed—among ships; and small discrepancies of such a kind often affect stability to an important degree. When vessels are found to belong to what is defined in the paper as a "type-form," the method is applicable, but where no true type-form can be discovered for a particular ship—and this is what usually happens in practice—the only reliable and also the readiest mode of approximation to a curve of stability is to compute by means of Amsler's integrator the true length of a small number of ordinates of the curve.

There are other papers of interest in this volume which are amply deserving of perusal, though we have not space for referring in detail to them. We may note, however, as an indication of the active and enlightened interest taken by Scotch engineers in scientific teaching, that the President of the Institution of Engineers and Shipbuilders in Scotland—in referring at one of the meetings to the endowment of the John Elder Chair of Naval Architecture in Glasgow University, which is filled by Prof. F. Elgar—said that "the Council had agreed, and were morally bound, to support the institution of a lectureship in anticipation of a Chair of Naval Architecture in the University." Mr. Reid further stated that "the Council had agreed to continue the lectureship in connection with the Chair," and he wished it to be known that the original intention was still to be carried out. This is a strong practical proof of the earnestness and wise liberality of Scottish engineers in the matter of scientific and technical education, and it is a policy which cannot fail to largely benefit the district in time to come. It is also one indication, out of many, of the advantages which may confidently be looked for by engineers and scientific men as the natural outcome of such institutions as those we have referred to.

THE EGGS OF MONOTREMES

SPEAKING at the anniversary meeting of the Royal Society in November 1883, Prof. Huxley said:—"It certainly was high time that British science should deal with a problem of the profoundest zoological interest, the materials for the solution of which abound in, and are at the same time confined to, those territories of the Greater Britain which lie on the other side of the globe." These words had reference to the series of investigations which Mr. Caldwell—the first Balfour Student—had then gone to Australia to prosecute with regard to the embryology of the lowest Mammalian forms, the Monotremes and Marsupials.

Somewhat less than a year later, and whilst the British Association was holding its meetings in Montreal, Prof. Moseley, the President of the Biological Section, was enabled to communicate the following brief but suggestive message telegraphed from Australia:—"Caldwell finds Monotremes oviparous; ovum meroblastic." Brief as was the message, it yet, as Prof. Moseley said, contained the most important scientific news which had been communicated to the Association in Canada.

Zoologists will now look forward with deep interest to the publication of Mr. Caldwell's more detailed account of his recent investigations, which have apparently enabled him to confirm so fully what has before been suspected, but never actually proved to be the case.

That Monotremes are oviparous has been maintained by various naturalists for now some sixty years: but up till the present time no sufficient evidence has been brought forward to place the matter beyond dispute, the chief difficulty in elucidating the problem lying in the fact that the two curious groups of animals which alone are placed in the Monotremata inhabit exclusively the Australian region, and hence have been but little studied in their natural habitat.

Though they are closely allied, yet the Ornithorhynchus and Echidna differ markedly from each other in external appearance—the one being adapted to the water, having its feet webbed, and its muzzle of that peculiar shape which has earned for it the name of Duck-billed Platypus, whilst the other is essentially a land animal, feeding on ants which it licks up by means of a long flexible tongue, and having its body covered with sharp spines, much as a hedgehog.

The question of how these animals reared their young, and in what condition the latter were born, has long been a matter of much dispute, and for information we are principally indebted to the memoirs of Home, Meckel, Geoffroy St. Hilaire, and perhaps most of all to Owen; whilst from time to time short notices are to be found in the *Proceedings* of the Zoological Society and the *Journal* of the Linnean Society.

In 1829 Geoffroy St. Hilaire laid a communication before the Royal Academy of Sciences in Paris, entitled "Considérations sur les œufs d'Ornithorinque formant de nouveaux documens pour la question de la classification des Monotrêmes."[1] Herein he stated his opinion that the Monotremes could no longer be admitted amongst the mammals, nor could they be classified with either birds, or reptiles, or fishes, but they must, though including only two groups of animals, be formed into a distinct fifth class among the Vertebrata, which would hence be divided, according to him, into Mammals, Monotremes, Birds, Reptiles, and Fishes.[2] The most interesting part of his paper, from our present point of view, however, consists of a letter which he quotes in full from Prof. Robert E. Grant of London, who describes in some detail the finding by a certain Mr. Holmes, whilst shooting on the banks of the River Hawksburgh in Australia, of a nest of eggs laid by an Ornithorhynchus; the animal was seen to hasten away from a sandy bank and plunge into the water. Examination of the bank led to the discovery of a small burrow, in which, on a rude nest made of twigs, were deposited nine eggs of a peculiar shape and size, which rendered them clearly distinguishable from those of any bird. The eggs, he says, are remarkable "par une forme régulière sphéroïdale oblongue, par une égale largeur à chaque bout; ils ont (mesure anglaise), en longeur de pouce, $1\frac{3}{8}$, et en largeur $0\frac{5}{8}$; la coquille est mince, fragile, légèrement transparente, et d'une couleur uniforme d'un blanc mat; sa surface extérieure, vue à la loupe, présente une texture d'un réseau admirablement réticulé; la matière calcaire a produit les parois blanches de ses innombrable et très-petites cellules, ce qui n'empêche pas que la surface n'en demeure à peu près polie.

[1] *Annales des Sciences Naturelles*, t. xviii. p. 162; also *Bulletin de la Société Philomathique*, t. viii. p. 95.

[2] The same idea is to be found also in Lamarck, *Philosophie Zoologique*, t. i. p. 145. Lamarck adds, further, "Ce ne sont point des mammifères; car ils sont sans mamelles, et très-vraisemblablement ovipares."

Un des œufs était cassé, et j'en ai examiné la surface interne, laquelle m'a paru être aussi formée par un dépôt de très-petits grains de la matière calcaire." He further states that the dimensions and form of these eggs remind him of those of many of the Saurian reptiles and Ophidians; whilst Jarrel, who examined them, came to the conclusion that they differed as much from the eggs of birds as from those of reptiles.

Fig. 1 is copied from a drawing which accompanies the paper of Geoffroy St. Hilaire, and represents its actual size and form.

Of the nine eggs which were discovered in the nest four were brought to England, and of these two found their way to the Manchester Museum, where, Prof. Williamson has kindly informed me—whilst he was curator, from 1835 to 1838—he distinctly remembers

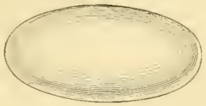


FIG. 1.

their being placed and labelled as "eggs of Duck-billed Platypus."

In 1826 Meckel, of Halle, had published a monograph on *Ornithorhynchus paradoxus* (Leipzig, 1826), wherein he announced the discovery of mammary glands, rudimentary in condition, but still undoubtedly present, and serving for the nutrition of the young; Geoffroy St. Hilaire, who, as before said, was strongly of opinion that the Monotremes could not be included amongst the Mammalia, suggested that the nature of these glands had not been sufficiently studied, and that instead of being mammary they were very probably analogous to those spread out on the flanks of aquatic reptiles, and which served to lubricate the skin; if this were not the case, he further suggested a comparison between them and certain odoriferous glands existing in the neighbourhood of the mammary glands in shrews.[1]

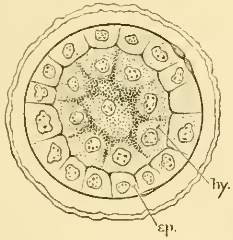


FIG. 2.

To these criticisms Meckel urged in reply the strong argument that they were only known to exist in female Monotremes, the males possessing no such structure, and later still Owen published his account of the "Mammary Glands of *Ornithorhynchus paradoxus*" (*Phil. Trans.* 1832). In this paper also he quotes the following passage from Meckel ("*Ornithorhynchi paradoxi* Anatome," p. 58):—"The difference between the bringing forth of living young and of eggs is really very small, and by no means of an essential nature: birds have accidentally hatched the eggs within the abdomen, and so produced a living fœtus—an occurrence which has been induced by direct experiment; and lastly the generation of the Marsupial animals is very similar to the oviparous mode." Meckel, Owen says, deems it "very probable that as the Ornithorhynchus approaches still nearer than the Marsupials to birds and reptiles, its mode of generation may be in a proportionate degree analogous."

[1] *Proc. Zool. Soc.*, 1833, pp. 28 and 91; also, "Memoir on the Abdominal Glands of Ornithorhynchus, falsely presumed to be mammary, but which secrete, not milk, but mucus, destined for the first nutriment of the young when newly hatched," *Gazette Médicale*, February 18, 1833; also, *Annales des Sciences Naturelles*, tom. lx. p. 457.

Somewhat later Owen published an account of an Ornithorhynchus fœtus,[1] which measured only two inches in length. After describing its external appearance he says, "On the middle line of the upper mandible, and a little anterior to the nostrils, there is a minute fleshy eminence lodged in a slight depression. In the smaller specimen this is surrounded by a discontinuous margin of the *epidermis*, with which substance therefore, and probably (from the circumstance of its being shed) thickened or horny, the caruncle had been covered. It is a structure of which the upper mandible of the adult presents no trace, and is obviously analogous to the horny knob which is observed on the upper mandible in the fœtus of some *birds*. I do not, however, conceive that this structure is necessarily indicative of the mandible's having been applied, under the same circumstances, to overcome a resistance of precisely the same kind as that for which it is designed in the young *birds* which possess it. The shell-breaking knob is found in only a part of the class, and although the similar caruncle in the Ornithorhynchus affords a curious additional affinity to the *Aves*, yet as all

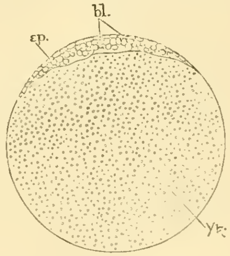


FIG. 3.

the known history of the ovum points strongly to its ovo-viviparous development (see also *Phil. Trans.*, 1834, p. 555), the balance of evidence is still in favour of this theory."

Later still (*Phil. Trans.*, 1865, p. 671) he published a paper on the "Marsupial pouches, mammary glands, and mammary fœtus of the *Echidna hystrix*," wherein he proved that the same caruncle was present in the Echidna fœtus, and further that this was carried about by the mother in a pouch (two being present in each individual, one on either side the middle ventral line), into which opened the mammary glands.

Owen adheres firmly to the opinion that the Monotremes are ovo-viviparous, in which opinion he is supported by the evidence of, amongst others, Sir E. Home (*Phil. Trans.*, 1802, p. 67), whose account is probably the earliest notice of any detail, which was published in England with regard to the internal anatomy of Ornithorhynchus.[2] Home says at the close of his paper, "this animal having no nipples and no regularly formed uterus, led me to examine the female organs in birds to see if there was any analogy between the oviducts in any of that class and the two membranous uteri of this animal;

[1] *Trans Zool. Soc.*, vol. i. p. 222; also *Proc. Zool. Soc.*, 1834, p. 43.

[2] For one of the earliest figures, see Shaw's *Naturalist's Miscellany*, vol. ix. 1799, and for figure of Echidna *vide op. cit.* vol. iii. 1792, under name of *Myrmecophaga aculeata*. Shaw says of Echidna, "It is also a most striking instance of that beautiful gradation so frequently seen in Nature, by which creatures of one tribe or genus approach to those of a very different one. It forms a connecting link between the very distant genera of Hystrix and Myrmecophaga; having the external aspect of the one with the mouth and peculiar generic characters of the other."

but none could be observed, nor would it be easy to explain how an egg could lie in the vagina to receive its shell, as the urine from the bladder must pass directly over it. Finding they had no resemblance to the oviducts in birds, I was led to compare them with the uteri of those lizards which form an egg that is afterwards deposited in a cavity corresponding to the uterus of other animals where it is hatched; which lizards may be therefore called ovo-viviparous, and I find a very close resemblance between them."

There has been, however, a certain amount of direct evidence brought forward beyond that which has been quoted from Geoffroy St. Hilaire's paper to prove that Monotremes are really oviparous, notwithstanding the fact that they nourish their young by means of mammary glands.

Thus a Dr. Nicholson (*Phil. Trans.*, 1865, p. 683), writing to Owen in 1865, informs him that a Platypus had been captured by workmen on the banks of the River Goulburn in Victoria, and had been placed for a night by the gold-receiver of the district, to whom it had been handed over, in a wooden case, and that whilst in confinement it had laid two eggs—white and soft, with no calcareous covering, and about the size of a crow's egg. Dr. Nicholson does not, however, appear to have taken the trouble to examine the eggs at all carefully, and his evidence is rejected by Owen as certainly insufficient to make him doubt that the Monotremes are ovo-viviparous.

Earlier still in Messrs. Lesson and Garnot's "Voyage de la Coquille" (*Zool. Journal*, vol. v.), it is stated that the colonists assured the travellers that Ornithorhynchus was oviparous, whilst a Mr. Murdoch, superintendent of the farms on Emu Plains, said that he himself had seen the eggs, that they were two in number, and the size of a hen's egg.

Again, Dr. Weatherhead (*Proc. Zool. Soc.*, 1832, p. 145) read, before the Zoological Society in 1832, extracts from a letter received by himself from Lieut. Maule in New South Wales, wherein the latter describes in some detail the finding and unearthing of an Ornithorhynchus burrow. The entrance to the latter, he says, is beneath the water, though, after some little distance, the passage rises, and, after a few yards have been traversed, it "branches into two others, which, describing each a circular course to the right and left, unite again in the nest itself, which is a roomy excavation lined with leaves and moss, and situated seldom more than twelve yards from the water or less than two feet below the surface of the earth: several of these nests were with difficulty discovered. No eggs were found in a perfect state, but pieces of a substance resembling egg-shell were picked out of the debris of the nest. In the insides of several Platypi which were shot were found eggs of the size of a musket-ball and downwards, imperfectly formed however, *i.e.* without the hard outer shell, which prevented their preservation."

Dr. Bennett also (*Proc. Zool. Soc.*, 1859, p. 213) investigated the structure of the Monotremes and examined the nest of Platypus, but failed to find traces of eggs.

Lastly, Mr. Patrick Hill, surgeon in the Royal Navy, published in *Trans. Linn. Soc.*, xiii. p. 621, information which had been brought to his notice concerning the Monotremes whilst studying their nature and habits in the district around Sydney. A female specimen was brought to him which had been taken directly from its nest, but which died very soon after being placed in confinement. On opening the body he discovered in the left ovary a round yellow ovum about the size of a small pea and two of smaller size, whilst no trace of ovisac was to be found in the right ovary;[1] but beyond his own investigations he brings forward the evidence of a certain Cookoogong, chief of the Boorah-Boorah tribes, who, as is quaintly remarked in Geoffroy St. Hilaire's article, "ne manquait ni de lumière ni de moralité." This native chief stated that it was a fact well known to their tribe that the animal lays two eggs, about the size, shape, and colour of those of a hen, and that the female sits a considerable time on her eggs in a nest which is always found among the reeds on the surface of the water; the native name for the Platypus, he added, was Mullingong.

The most important part of Mr. Caldwell's communication to the British Association was, however, contained in the two words "ovum meroblastic"; in other words, the ovum of a Monotreme contains, relatively to the pure protoplasm out of which the tissues of the animal will be formed, so much food-yelk that, when segmentation takes place, it is impossible for the egg to segment as a whole, and therefore the two kinds of protoplasm separate, and we find that the Monotreme embryo possesses a yelk-sac, by the gradual absorption of the contained material of which it is nourished during the early stages of development.

The presence of so large an amount of food-yelk thus renders it unnecessary that during this period the tissues of the embryo should enter into such a close relation with the maternal ones as is found to obtain in the rest of the Mammalia, though even amongst the higher members of the latter there are certain signs which point to a former period in their phylogenetic history when they also were possessed of a yelk-sac.

Figs. 2 and 3 represent respectively examples of holoblastic and meroblastic ova at very early stages, the one being that of a rabbit, the other that of a Sauropsidan, and it is to the latter that the ovum of Monotremes bears a close resemblance.

In both cases it is interesting, however, to observe that a structure is eventually formed known in birds and reptiles as the yelk-sac and in most mammals as the umbilical vesicle, the two being really homologous with each other.

Now that Mr. Caldwell has shown that in the lowest mammals a yelk-sac is present containing food-yelk instead of an umbilical vesicle as in the higher forms, it may be affirmed that the curious stages in the development of most Mammalia which result in the pinching off of the embryo and the formation of an umbilical vesicle are indications still remaining of the time when these animals were nourished during early stages, not directly by a close union with the maternal tissues, but by means of yelk-sacs: it affords evidence, in fact, that their ancestors were not viviparous, but oviparous, just as are the lowest mammals now known to us.

During late years various theories have been held concerning the origin of mammals: Balfour formed a hypothetical group—the Pentadactyloidei—in which he supposed the pentadactyle limb characteristic of all the higher vertebrates to have been established: from this he derives two groups—the one including the present existing Amphibia, the other being a hypothetical and somewhat generalised group, from which, though along divergent lines, were developed both Mammalia and Sauropsida. Thus, according to him, the two latter were branches from one common stem, but the Sauropsida could not be considered as the ancestor of the Mammalia.

Other scientific men have held that mammals were derived from Amphibia-like ancestors: with the present Amphibia they were supposed to agree in the presence of a holoblastic ovum, and in the important fact that in both groups two occipital condyles are present, whilst only one is typically found in the Reptilia.

It is interesting to notice that Cope has described, amongst the numerous extinct forms of reptiles which he has brought to light during the past few years, one, called by him the Theromorpha (*Proc. Am. Phil. Soc.*, vol. xix.

[1] See also Owen, "Anat. of Vert.," vol. iii. p. 676; also *Proc. Zool. Soc.*, 1834, p. 143.

p. 38), which he regards as intermediate between Reptilia and Mammalia. He says:—"The order Theromorpha approximates to the Mammalia more closely than any other division of Reptilia. This approximation is seen in the scapular arch and humerus, which nearly resemble those of the Monotremata, especially Echidna; and in the pelvic arch, which Owen has shown in the sub-order Anomodontia to resemble that of the mammals, and, as I have shown, especially that of Echidna. The tarsus is also more mammalian than in any other division of reptiles. In the genus Dimetrodon the coracoid is smaller than the epicoracoid, as in Monotremes. The pubis has the foramen for the internal femoral artery." Cope also appears to have found in the Theromorpha a spur attached to the hind foot, just as in the males of Monotremata.

In the skeletons of the latter, on the other hand, we find several prominent features in which, whilst they differ from the typical mammalian forms, they approximate more or less closely to the reptiles, whilst finally Mr. Caldwell's discovery with regard to the nature of the ovum has shown that Mammalia and Sauropsida are closely allied to each other—more intimately than has generally been allowed by naturalists.

In Monotremes we find, as it were, intermediate animals possessing the attributes of two classes: whilst on the one hand they have developed mammary glands, the distinctive feature of the higher group, on the other they lack that structure whereby the typical mammalian embryo receives nourishment before birth; and in correlation with this we find them agreeing with the lower class in the possession of a yelk-sac, whilst the contained food-yelk causes the ovum to assume the meroblastic type.

We may thus trace the line of descent through the Sauropsida directly to the Monotremes (doubtless through forms now extinct, as the Theromorpha of Cope); from these to Marsupials, which are indeed viviparous, but whose ova still possess a large yelk-sac, and whose embryos, as Mr. Caldwell (*Q.J.M.S.* October 1884) has just shown, enter into no close vascular connection with the maternal tissues; and from these to the higher mammals, whose much specialised structures for fœtal development differ now so widely from those of the lower vertebrates.

W. BALDWIN SPENCER

NOTES

LAST Thursday (December 4) the Chemical and Physical Society of University College, London, gave a scientific *soirée* in connection with the University College Society. Prof. T. G. Bonney delivered the annual address, and took as his subject "Serpentine Rock and its Origin." The lecture was illustrated by Wright and Newton's new oxy-hydrogen microscope. During the evening demonstrations were given on "Radiant Matter" by Mr. Rose Innes, "Absorption Spectra" by Mr. Schunck, and "Ozone" by Mr. E. E. Craves, in various parts of the building. In the library were exhibited by several gentlemen and manufacturers new scientific apparatus and chemical compounds. The physical and chemical laboratories were thrown open to visitors, and in them were shown new forms of apparatus for research. The meeting was numerously attended, and the committee are to be congratulated on the success of the evening.

THE ordinary general meeting of the members of the Parkes Museum was held on Thursday, December 4, Capt. Douglas Galton, C.B., F.R.S., in the chair. The meeting was held to consider the report of the Council for the tenth year and to elect officers. The report set forth the work done in connection with the Museum during the past year, which had included lectures by the Council of the Sanitary Assurance Association in addition to those arranged by the Council of the Museum. The accounts showed that there was urgent need for increased subscriptions if the Museum was to be continued, for the small invested capital had had to be made use of this year to meet the current expenses. The report was adopted on the motion of the Chairman, seconded by Mr. Rogers Field. Mr. Mark H. Judge, then proposed "That the report be printed for circulation, with a detailed statement of the financial position of the Museum, and that a special meeting of the members be convened within two months to consider the same." This was seconded by Mr. E. C. Robins, and carried unanimously. Sir R. Lloyd Lindsay, Prof. J. Marshall, F.R.S., and Mr. Alfred Waterhouse, A.R.A., were elected Vice-Presidents. Six new Members of Council were elected, and the meeting closed with a vote of thanks to the Chairman, proposed by Dr. J. C. Steele of Guy's Hospital.

WE have before us a most satisfactory report of the Manchester Public Free Libraries for 1883–84, showing increase everywhere. More than one and a quarter million of issues have been made to two and a half million of visitors to the libraries. Of these the boys have been provided with additional reading-rooms to themselves, which are reported as crowded every evening; the increased Sunday issues of books also are noted as being specially made to boys, and it cannot be doubted that a taste for reading thus early implanted will save them from half the temptations to which idle youth is subjected. While nearly 10,000 new books have been purchased, more than 10,000 have been started in new harness for fresh toil by the bookbinder; and few items can speak better of "something accomplished, something done," than 3325 volumes withdrawn from circulation, simply worn out. At one branch a new catalogue published, at another one preparing, and at a third two supplementary lists issued, keep the value and the availability of the books at the highest point.

AT the meeting of the Geologists' Association last Friday, Mr. R. Meldola gave a preliminary account of his investigation of the East Anglian earthquake of April 22, 1884, with special reference to the geology of the question. The extreme limits of the recorded disturbance were Brigg in Lincolnshire, Altrincham in Cheshire, Worcester, Bristol, Street (Somersetshire), Boulogne, and Ostend, giving in round numbers an area of 50,000 square miles. The focus of the disturbance appears to have been beneath the earth near the villages of Abberton and Peldon, between Colchester and Mersea Island, and there seems to have been total reflection of the shock at Wivenhoe on the River Colne, the tract of country to the north-east of this village, where great damage was sustained, being in "seismic shadow." The area of structural damage comprised about fifty or sixty square miles, the main axis being along a line five miles in length and extending in a S.W.–N.E. direction from Peldon to Wivenhoe. The evidence showing the propagation of the shock along the older rocks had been carefully considered, and the conclusion had been arrived at that such a spreading of the shock towards the west, north-west, south-west, and south-east had actually taken place, an additional argument in favour of the extension of the Palæozoic rocks beneath the south-east of England, as first suggested by the late Godwin-Austen in 1855, being thus furnished. It was pointed out that this extension of the disturbance along the older rocks was of a purely dynamical character, depending simply upon the superior elasticity of these formations. One phase of earthquake movement which the present disturbance appears to have revealed with special distinctness was the tendency of the shock to make itself felt along free margins such as coast-lines, river-valleys, lines of outcrop, &c. The general conclusion respecting the distribution of earthquakes in this country which the present investigation

had led to was that earthquakes having their focus in the east of England would be likely to extend much further west than those originating in the west would extend eastwards, this depending upon the geological structure of the country and being supported by the records of previous British earthquakes, of which a complete catalogue was in course of preparation. Mr. Meldola stated that the complete report, which was very voluminous, was nearly ready for publication.

WITH reference to the palæontological discovery of a fossil scorpion in the Upper Silurian formation of Gothland, recently made by Prof. G. Lindström of the Academy of Sciences, Stockholm, which has attracted considerable attention on the Continent, we have received the following communication from this *savant*:—"The discovery was made in the latest Upper Silurian layer. Only the thin chitinous coat has been preserved, all the soft membranes having decayed, and the body is compressed, owing to the pressure of the superincumbent layers. Like the scorpions existing at the present time, its body consists of the cephalothorax, seven abdominal membranes, and seven segments in the tail, of which the seventh is distinctly shaped into a poisonous sting. Both the great claws (*palpi*) still remain; the number of legs was eight, those of the left side being in perfect condition. They differ entirely from all known scorpions, fossil or living, by the joints being thick and heavy and the leg ending in a point instead of claws. There is a marked respiratory cavity (*stigma*) on the right side, from which I draw the conclusion that it was not only an air-breathing animal but an animal living on *terra firma*. Its whole construction points to this. It is the oldest known land-animal, the limits of our knowledge as to its existence during past ages having been extended from the Middle Devonian strata of Canada, where remains of Neuroptera have previously been found, to the uppermost strata of the Upper Silurian formations."

THE Mersey Tunnel is now completely arched in under the river with the exception of the inverts. It is interesting to geologists to know that, about three hundred yards from the Liverpool side, the upper part of the tunnel intersected the pre-Glacial bed of the river for a distance of about one hundred yards. This "gully" in the rock was filled with hard Boulder-Clay, with erratic boulders resting upon the hard denuded surface of the Triassic sandstone. As showing the importance of a knowledge of geology in engineering works, this pre-Glacial gully was, in opposition to the prevailing opinion, foreseen and predicted as one of the difficulties that would have to be encountered in the tunnel-works in a paper by Mr. Mellard Reade, entitled "The Buried Valley of the Mersey," published in the *Proceedings* of the Liverpool Geological Society in 1872. It is very satisfactory to know that this difficulty is now surmounted, and the stability of this important and interesting work placed beyond a doubt.

As we anticipated some weeks ago, M. Joseph Bertrand has been elected a Member of the Académie Française almost without opposition, having obtained twenty-five votes out of a total of twenty-six, the single dissentient voice having been given in favour of a poet who could hardly be termed a candidate. M. Bertrand's formal reception into the Academy will take place in the course of a few months, and M. Pasteur is to reply to the speech he will deliver on the occasion.

M. JANSSEN is at present engaged in drawing up for the Academy of Sciences a full report of his mission to the Prime Meridian Congress at Washington. He is also to deliver a lecture on the subject before the Geographical Society of Paris. The learned astronomer still adheres to his scheme of a neutral meridian.

MANY of our readers are aware that when Mr. Thiselton Dyer, more than ten years ago, introduced at South Kensington a system of instruction in botany based on the same principle as the instruction in animal morphology already introduced by Prof. Huxley, he intended to put together the results of his experience in the form of a hand-book for the use of other teachers. Pressure of other work prevented his carrying out his intention, but Mr. F. O. Bower, now Lecturer in Botany in the Normal School of Science, took the task in hand in conjunction with Dr. Sydney Vines, and we are glad to be able to announce that Messrs. Macmillan and Co. will publish a first instalment of the work immediately. When complete, according to the original scheme, the work is intended to contain a general introduction by Mr. Dyer, introductory chapters on methods and on the morphology of the cell by Dr. Vines, and then the description of a series of types representing the various groups of the vegetable kingdom. In each case a short general description will precede the directions for investigating the type in the laboratory. The instalment now promised will contain an explanatory preface by Mr. Dyer, the two introductory chapters by Dr. Vines, and the directions for laboratory work on vascular plants, as represented chiefly by the following types:—*Helianthus annuus*, *Ulmus campestris*, *Zea Mais*, *Pinus sylvestris*, *Selaginella Martensii*, *Lycopodium clavatum*, *Aspidium Filix-mas*, and *Equisetum arvense*. It is hoped to publish the laboratory directions for the remaining types, and the short prefaces to each type, before very long. For the laboratory directions Mr. Bower is mainly responsible; the descriptive prefaces will be contributed by Mr. Dyer; but the whole work will have undergone the minute supervision of all the three authors concerned, and represent their united experience.

MESSRS. MACMILLAN AND CO. promise immediately an abridged edition, for popular use, of the "Life of Prof. J. Clerk Maxwell."

THE following are the lecture arrangements at the Royal Institution before Easter 1885:—Six lectures (adapted to a juvenile auditory) by Prof. Tyndall, on the Sources of Electricity, on December 27 and 30, 1884, January 1, 3, 6, and 8, 1885; five lectures by Prof. H. N. Moseley, on Colonial Animals, their Structure and Life-Histories, on Tuesdays, January 13 to February 10; four lectures by Dr. Arthur Gamgee, on Digestion, on Tuesdays, March 3 to 24; eleven lectures by Prof. Dewar, on the New Chemistry, on Thursdays, January 15 to March 26; three lectures by Dr. Waldstein, on Greek Sculpture from Pheidias to the Roman era, on Saturdays, January 17 to 31; three lectures by Mr. G. Johnstone Stoney, on the Scale on which Nature works, and the Character of some of her Operations, on Saturdays, February 7 to 21; and five lectures by Mr. Carl Armbruster, on the Life, Theory, and Works of Richard Wagner (with illustrations, vocal and instrumental), on Saturdays, February 28 to March 28. The Friday evening meetings will begin on January 16, when Prof. Tyndall will give a discourse on Living Contagia.

THE archæologist M. Saillard, well known through his indefatigable efforts for the preservation of dolmens, has discovered the workshop of a prehistoric armourer or smith on a steep rock by the sea on the south-west side of the peninsula of Quibéron (Brittany). It dates from the Stone Age. Polished lances, arrow-heads, axes, and other objects are represented in great numbers and in every stage of manufacture, so that the discovery is most interesting, inasmuch as the objects illustrate the workman's method and process. Amongst the objects is also a meteoric stone worked into an implement. The skeleton of the workman was also found, the skull being very well preserved.

DR. AUGUSTUS VOELCKER, F.R.S., died on Friday last, the 5th inst., at his residence, 39, Argyll Road, Kensington, in his sixty-second year. He was born at Frankfort-on-the-Maine,

received his chief education at the University of Göttingen, and in early life came to England. After that time he successively held the post of assistant to the late Prof. Johnston at Edinburgh, Professor of Chemistry in the Royal Agricultural College at Cirencester, and Professor of Chemistry to the Royal Agricultural Society of England, and was well known as the author of several works in theoretical and agricultural chemistry, such as the "Chemistry of Food" and the "Chemistry of Manure."

THE *Journal of Botany* for December contains a memoir of the late George Bentham, accompanied by an excellent photograph.

WE have received the prospectus of the Royal Agricultural College, Cirencester, issued during the past month. The course of instruction provided in technical and scientific subjects appears to be ample for the requirements of the agricultural students. We are glad to notice that external examiners are appointed for the final examination of students for the diploma, and also that a Board of Studies, in which are several professors otherwise unconnected with the College, exists. The number of students is steadily increasing, and among them are several Indian scholars sent by the Governments of Bengal and the North-West Provinces. The Governments of the Indian Presidencies also encourage some of their civil servants to pass through the College course when on leave of absence in this country.

ON the subject of agricultural education, a correspondent writes to the *Times* that a number of meetings have recently been held in Oxfordshire and Buckinghamshire with a view to the establishment of night classes during the winter for teaching the scientific principles of agriculture. There is, he says, a growing opinion among the more educated young men that agriculture requires something besides Commissions and inquiries and fair trade. It has been estimated that the annual waste from careless and unskilful methods of managing manure amounts to nearly five millions sterling. Add to this the want of knowledge in the purchase of artificial manures and their application, the waste of feeding-stuffs, the odd pieces and corners of fields that might grow other things beside rank weeds and couch-grass, and the waste of time in going to markets, auctions, and fairs. No reduction of rent or local taxation, or increased price of wheat, will, says this correspondent, do anything for men who make no effort to improve their industry by increased scientific knowledge. The natural history of the wire-worm, the leather-jacket, the dissolving of bones, the building up of plants, the judicious mixing of food, and many other things which farmers would be the better for knowing can never be acquired by what is called practical farming, and accordingly these classes are commended to the consideration of all who take an interest in the welfare and education of young men in rural districts.

THE additions to the Zoological Society's Gardens during the past week include a Yellow Baboon (*Cynocephalus babouin* ♂), a Chacma Baboon (*Cynocephalus porcarius* ♀) from the East Coast of Africa, presented by Capt. Edward Jones, R.N.R.; a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. Geo. Airey; a Bittern (*Botaurus stellaris*), British, presented by Mr. Robert Page; a —— Otter (*Lutra* ——) from South America, a Cat Fish (*Amiurus catus*) from North America, deposited; two Rock Pipits (*Anthus obscurus*), British), a Passerine Owl (*Glaucidium passerinum*), a Crested Titmouse (*Parus cristatus*) from Siberia, purchased.

OUR ASTRONOMICAL COLUMN

WOLF'S COMET.—Herr Lehmann-Filhés of Berlin has made a first approximation to the amount of perturbation experienced by this comet at its near approach to the planet Jupiter in 1875, to which attention was directed in NATURE (vol. xxx. p. 615). He adopts the orbit determined by Prof. Krueger upon observations extending over an interval of forty-eight days, and applies the formulæ of the "Mécanique Céleste" (liv. ix. chap. ii.), which were first employed by Burckhardt in the case of the celebrated Lexell comet of 1770. The following are the elements deduced for perihelion passage in 1868, or the elements defining the orbit of the comet previous to its close approach to Jupiter; we annex Prof. Krueger's orbit for the present appearance for comparison:—

	Lehmann-Filhés, 1868	Krueger, 1884
Perihelion passage ...	Sept. 24·6 M.T. Berlin ...	Nov. 17·7922
	° ′ ″	° ′ ″
Perihelion	352 36 48	19 3 17
Ascending node	207 33 50	206 22 17
Inclination	27 36 49	25 15 10
Angle of excentricity ...	16 11 5	34 3 12
Log. semi-axis major ...	0·663970	0·552936
Mean daily motion ...	358″·14	525″·536

The longitudes in both orbits are reckoned from the mean equinox 1884·0.

Prof. Krueger writes modestly as to the degree of accuracy of his elements, which have been adopted by Herr Lehmann-Filhés, nevertheless they were founded upon a fairly-wide interval of observation as noted above. From the nature of the problem, however, the orbit for 1868 must be regarded as roughly indicating the kind of track which the comet was then following. And it is to be remarked that the perihelion distance corresponding to the assigned values of excentricity and semi-axis major is 3·327, which would account for such a comet not having been observed while moving in the orbit of 1868. Thus, as in several previous cases, the comet appears to have been brought within range of visibility from the earth by the powerful attraction of the planet Jupiter.

THE WASHBURN OBSERVATORY, WISCONSIN.—Vol. ii. of *Publications* of this Observatory has been issued. Its main feature consists in a reduction of the star-gauges of Sir William Herschel, published and unpublished, or 683 gauges published and 405 unpublished, Prof. Holden having been indebted for the latter to Lieut.-Col. Herschel, R.E., who forwarded to him a complete copy of a manuscript, by Miss Caroline Herschel, in which they are given, and who was at the further trouble of extracting from the Herschel papers in the library of the Royal Astronomical Society the dates of the various sweeps. Also of 500 counts of stars from the published charts of Prof. C. H. F. Peters, 983 counts from his unpublished charts and those of Watson and Chacornac, and 781 from those of Palisa. Prof. Holden states that he is now discussing these various gauges by a graphical process, and that they promise to lead to very interesting results, especially when they are supplemented by other star-gauges covering the same ground and made by a larger instrument. The volume further contains a list of 111 new double-stars and two new nebulæ, with observations of red or coloured stars between December 1881 and the end of 1883, in continuation of a list given in the first volume.

GEOGRAPHICAL NOTES

REPORTS have been received from M. Alfred Marche, who is travelling through the Philippine Archipelago on a scientific mission for the French Ministry of Public Instruction. During June and July last he explored the archipelago of Calamienes, situated to the south-west of Mindoro and to the north of Paluan (Paragua) Island. This archipelago is composed of three large islands, Busuanga, Calamienes or Culion, and Linacapan, and about thirty smaller ones. M. Marche first visited Culion, the inhabitants of which are Tagbannas, similar to those whom he observed in a previous journey to Paluan. These form the principal as well as the most ancient people of the peninsula, and it is probable that formerly they occupied a much larger area than they do now. A small number of them, more or less Christianised, have submitted and built a village, to which, however, they come as rarely as possible. The others are independent, and are fetish-worshippers. In Culion there is but a single Spaniard, the priest. After Culion, M. Marche visited the island of Busuanga, where there were formerly Chinese colonies engaged in collecting birds' nests, and in trepang and pearl-fishing, both industries which no longer exist. In spite of continual rains the traveller was able to make a large collection of plants and of woods of all kinds. In Busuanga he came

across the inhabitants of Agutayo, one of the Cuyos Islands. They left their home, where they could hardly get enough to bring them to Busuanga, to fish for trepang and for small prawns, which they dried in the sun, and then sold to Chinese and Indians. M. Marche was able to take measurements of a certain number of these Agutaino. He gives long and interesting ethnographical details of the Tagbannas of this island, on their marriage ceremonies, funeral rites, &c. M. Marche then went in succession to the islands of Penon, Coron, Magao-Puyao, and Dibatac. In the last he observed that the hills, which are almost disafforested by the natives, and which are about two hundred metres in height, surround fertile plains in the form of a horse-shoe, more or less closed, and in the centre a depression is observable. The whole has the appearance of a funnel, and it is suggested that this is an extinct volcanic region. In the same island of Dibatac, crocodiles and boa-constrictors are very numerous, and M. Marche was able to capture one of the latter, which had swallowed a calf several months old.

On the 2nd inst. Mr. H. M. Stanley inaugurated the newly-formed Scottish Geographical Association in the Music Hall, Edinburgh. Lord Balfour of Burleigh presided. On the 4th Mr. Stanley formally opened the rooms of the Society, and on Saturday last he opened the Dundee branch of the Scottish Geographical Society in the Kinnaird Hall.

M. Romanet de Caillaud has communicated to the Geographical Society of Paris two papers on Tonquin. One refers to routes from the delta of the Red River into Yunnan, the other on the history of the Thai or Laos race in Tonquin and Southern Kwangsi. In the former he describes in detail five routes, two by river and three by land, into South-Western China. The only one of these of importance is that by the Songkoi, or Red River, and M. de Caillaud makes light of its difficulties, and insists that Paris is practically nearer to the Yunnan frontier than either Canton or Pekin. Paris is at the most, he says, fifty days' journey, while Canton is sixty, and Hankow, on the Yang-tse, eighty days. He also advocates this route for an invasion of China, and says that Lao-kai, on the upper Songkoi, is really for France the vulnerable point of that Empire. As has been already pointed out, discussion of the Songkoi route above Hong-hoa must for the most part be based on speculation, as only one European has travelled down or up the river from or to Manhao, and his journey was undertaken in circumstances which hardly admitted of accurate observation. A German geographer has recently expressed the opinion that one of the chief difficulties to be encountered in this route will be ethnological, and M. de Caillaud, in his second paper, traces briefly the fortunes of the principal race of the region—the Laos or Thai. This people has apparently had its day. At one time it dominated the whole Indo-Chinese peninsula, but now it is split up among a number of independent or semi-independent princelets, whose main business is war and piracy. Their various attempts to recover a portion of their old power have been repressed by the Annamites, assisted, when necessary, by the Chinese.

Lieut. Bove, of the Italian Navy, has written to Dr. Hyades of Paris a letter respecting his second expedition to Terra del Fuego The first, he says, was to some extent scientific. He was ordered by the Argentine Government to study the south of Patagonia and Terra del Fuego from an economical point of view, and scientific observations were merely adjuncts. Nevertheless a scientific commission to investigate the geology, botany, zoology, and hydrography of these regions was sent with him. Lieut. Bove's official report is about to appear in Spanish in Buenos Ayres, and will be accompanied by those of the scientific men engaged. The *Bolletino* of the Italian Geographical Society will contain a paper on his journey in the interior of Terra del Fuego among the Ona. He started from Ouchonaya with an escort of twenty-four Fuegians of the mission, who proved very useful to him. After crossing the mountains behind this place, he descended into the valley which runs down to Admiralty Sound. He describes the interior of the island as magnificent, and much richer than Patagonia. The Ona were met with but twice, and their total number is estimated at from 300 to 400. The total number of Fuegians in the whole archipelago is stated, according to a careful census made by an English missionary, the Rev. Thomas Bridges, to be only 949 men, women, and children.

M. Michel Venukoff has addressed a note to the Geographical Society of Paris, referring to a new map of the island of Saghalin, prepared by M. Nikitine, the topographer. It differs from all the other maps of the island in some respects. It shows it to be considerably larger than had been previously believed. M. Reclus gives the area as 63,600 square kilometres. M. Strelbitsky 67,018, and Venukoff 73,529. Although the writer claims that his bases for calculation were necessarily more detailed and exact than those of his predecessors, he nevertheless considers his figures as approximate rather than final.

SCIENTIFIC ASPECTS AND ISSUES OF THE INTERNATIONAL HEALTH EXHIBITION[1]

[THE first Wednesday lecture at the Society of Arts was devoted to an address on this subject—in accordance with precedents—the Duke of Buckingham, Chairman of the Exhibition Council, taking the chair. The following are the parts of the address relating to the scientific departments of the Exhibition, and the proposal which the lecturer is understood to have laid before the Council for some time for the disposal of the surplus to such objects.]

There was only one exhibit in the food department to which I would specially call attention, it was that from the collections of the Science and Art Department and the Parkes Museum, illustrating the constituents of food and food values, and the connected exhibit by the Society of Public Analysts, of materials used as adulterants of articles of food; of adulterated articles of food commonly sold in this country; of adulterations which have been suppressed; of adulterations practised abroad, and mixtures generally protected by labelling. This latter was added in consequence of a suggestion made by the late Mr. Wigner, President of the Society of Analysts, at a late date in the progress of the Exhibition. I am afraid that it did not attract all the attention that it deserved. I trust, however, we shall be able to reserve it for continual public reference. Mr. Wigner, in communicating with me, pointed out that, although the Exhibition was most successfully arranged so as to display in a prominent manner all the articles connected with food, yet the public were only shown what is done by the most careful and respectable firms, whose names are a sufficient guarantee that only materials of the highest quality are used in the preparation of the goods which they show.

All who are connected with food produce know how, from time to time, the desire on the part of the consumer for cheap goods is the cause of the introduction of articles called "substitutes," which are offered to the manufacturer at one-third the price of the genuine material, and which frequently consist of some cheap and simple preparation, the very opposite in its chemical character to the article for which it is said to be an efficient substitute: several cases of this kind had recently been brought to Mr. Wigner's notice. For instance, he referred to an article to be used as a substitute for tartaric acid, the composition of which has been found to be acid sulphate of alumina in solution—a substance which, if introduced into the manufacture of bread or biscuits, is as objectionable as alum, and quite as much an adulterant. Bisulphate of potash is also sold under a name similar to tartaric acid, and is equally as worthless as sulphate of alumina. These are only two instances out of many, and serve as an additional argument to show the keen competition in trade, which causes the manufacturer to produce, and unscrupulous firms to sell, such articles under "Royal Letters Patent," or some other heading of this sort, to attract the notice of the consumer.

The public analyst, Mr. Wigner added, although, of course, he should be cognisant of these facts, has quite enough work for the remuneration paid to him, and in addition to this, there is the fact that the Sale of Foods and Drugs Act is so limited in its aim and scope as to practically prevent the analyst from testing anything but the common articles of food, such as bread and milk, unless they are sold under some recognised name. Let him once travel outside these lines, and a whole host of objections are raised. What is really wanted is more stringent legislation, similar in character to that at present in operation in the United States and Paris.

In the French Section were shown the monthly reports of the Municipal Laboratory, showing the complete and thorough manner in which the food-supply of that city is protected. Why cannot something of the same sort be done in London? What is wanted is a measure defining what is and what is not adulteration, and prohibiting the use of articles which are fre-

[1] Extracts from an Address delivered at the Society of Arts on Wednesday, November 26, by Mr. Ernest Hart, Member of the Executive Council.

quently employed at the present time, and the sale of which, while benefiting one class, seriously injures another, by substituting an inferior article for one of better quality.

Considerable good, it may be hoped, was done by the Health Exhibition by the exhibition of these so-called substitutes. The prominent display of this instructural series in a National Exhibition has, we trust, done something towards putting a stop to a trade which, while it enriches the unscrupulous trader, places the honest manufacturer in an awkward position.

How far it has fulfilled this intention is of course not yet apparent, but I shall certainly feel it a part of my duty in another capacity, as Chairman of the Parliamentary Bills Committee of the British Medical Association, to endeavour to keep the attention of our legislators to this important subject. It may be hoped that, when the political horizon is sufficiently cleared to enable Parliament to devote some time to interests of almost as important, if less strictly party, a character as those which are now occupying their attention, that it may be possible to secure for the people of England, or at least for the people of this metropolis as an example to other great towns, some of those better securities against the adulteration of food which this country was the first to set the example of creating by legislative action, but as to which it has at the present moment fallen behind some of those countries which followed us, such as France, Belgium, and America. It is within my knowledge, and in fact within my personal experience, that in all those countries our English legislation was originally the model which they set before them. In fact, in the case of several of these countries, I have had the opportunity of receiving the gentlemen who had been sent over by their various Governments, and of furnishing them in several instances with the opportunities of study and materials of which the respective Governments have availed themselves to create model laws respecting adulteration; I would refer here especially to the German code.

It is hardly to our credit that we have allowed ourselves to be distanced in a race in which we had so considerable a start, and in which the sole goal is the public benefit, and the maintenance of the public health. These are questions largely affecting the health of the whole nation, and especially affecting the welfare of the poor, who suffer most by the substitution of worthless, inferior, or adulterated articles in the fabrication of apparently cheap, but often very dear because worthless, articles of food.

Heating, Ventilation, and Smoke Abatement.—The testing of exhibits in Classes 24 and 25—Heating and Ventilating—were carried out on a considerable scale. Some 120 kitcheners—some burning solid fuel, and some gas—were tested. A large house was rented for conducting these trials, under conditions approximating to those which would be found in the actual use of the apparatus by the public, and a large number of tests of cooking joints, &c., in the kitcheners, &c., were made. The importance and necessity of exact testing, initiated by the Smoke Abatement Committee of 1881, and since carried on in a systematic manner by the National Smoke Abatement Institution, were fully recognised by the Executive Council of the Health Exhibition. The series of testings were conducted by the acting engineer to the Smoke Abatement Institution, Mr. D. K. Clark, and the jury of the Exhibition dealing with these exhibits included Prof. W. Chandler Roberts, Mr. Robert Harris, President of the Gas Institute, and other members of the Smoke Abatement Institution whose special knowledge peculiarly fitted them for the work.

The practical advantages of such testings have been manifested in the great interest taken by exhibitors in the work, their general desire to submit their manufactures for testing, the evidently accelerated course of improvement in design since the Smoke Abatement Committee first introduced the system of tests, and the advanced knowledge derived from the results of those tests.

At the Health Exhibition these beneficial influences were clearly traceable in the adoption of good ideas embodied in apparatus shown at the Smoke Abatement Exhibition in 1881, and brought into notice by the testing treatments adopted there, as well as in the rejection of plausible but impracticable methods of heating and ventilation which found place in the earlier exhibition. The detailed report of the tests of the apparatus shown at the Health Exhibition I trust will be published, for it will form a valuable addition to a continuous and advancing series of tests. The importance of this branch of my subject can hardly be exaggerated. We can follow, in the light of the knowledge derived from the result of the later tests, a regular and most encouraging course of improvements. For example, some of the exhibits shown at the Crystal Palace Exhibition last year, in the class of gas-cooking and heating-stoves, were proved to have a greater efficiency, by about 20 per cent., than those shown at the Smoke Abatement Exhibition in 1881; while at the Health Exhibition the efficiency proved by the tests was fully 25 per cent. greater than at the original Smoke Abatement Exhibition. Besides this increased efficiency, or improvement, to be measured by lower consumption of gas for equal work done, there has been an improvement hardly less important in numerous points of detail, affecting both the durability of the apparatus, and the facility with which it can be cleaned. These latter improvements, added to the lessened price of gas, and the reduced consumption of it in the newer forms of stove, cannot fail to tend towards the increased use of these cleanly conveniences and smokeless heating appliances for domestic purposes.

The testings at the Health Exhibition brought out the merits of a number of kitcheners and stoves very well adapted for using coke and "slack," or small coal, as well as improved patterns for using the ordinary lump coal, with lessened production of smoke. In regard to the advance made in smoke prevention from domestic fires, I may mention, on the authority of the testing engineer, that the highest average smoke shade proved by the tests of 1882 was 4·18 from kitcheners; and in the test at the Health Exhibition, the highest average was only 2·4; and from open grates the average density of the smoke was 3·0 in 1882, and at the Health Exhibition it was only 1·75. The importance of facilitating, by means of improved apparatus, the use of coke and the cheaper fuels now generally wasted is obvious, and I think I may fairly claim that this section of the Exhibition achieved a highly useful and successful result. In the bakeries department no less than five distinct systems of heating bakers' ovens, practically without the production of any smoke whatever, were shown—and not only shown, but were proved by an extended course of actual working—to be more or less well suited to the requirements of the trade. Varieties of machines for making dough by cleanly and expeditious methods were successfully worked throughout the period of the Exhibition, and it is but reasonable to assume that the exhibition of these machines, shown daily in satisfactory working, must have a great future influence in putting a stop to the laborious and filthy process of making dough by manual labour.

The Library.—The library sub-committee report with great satisfaction that the library has proved an unqualified success, and that it has attracted not only a large number of readers, but a considerable proportion of serious students.

Although no purchases of books have been made, upwards of 5000 works are now included in the collection, of which over 3000 relate to health subjects. The great majority are free gifts, a small proportion are on loan. They express a strong hope that a collection of books so useful as the nucleus for the formation of a special library will not be dispersed, but that the Executive Council will devise means to maintain the library on a permanent footing, as part of a memorial of this useful and successful national undertaking.

The library was altogether a novel feature in any exhibition of the kind, and its value was attested by the considerable number of serious students who availed themselves of its extensive resources, many of them being University students, who used this unwonted opportunity in preparing for examinations. The advantages to be derived from retaining the library as a permanent institution would be great. I put before you a copy of the catalogue, made entirely by Mr. Carl Thimm. This catalogue is in itself a publication of no small interest, being the most complete catalogue of sanitary literature with which I am acquainted (although of course it cannot be said to be complete in even an approximate sense, but must only be regarded as a very valuable nucleus for a larger library), in which the hygienic literature of foreign nations, and especially their official hygienic literature, is very largely and well represented.

The Sanitary and Insanitary Houses.—Of the sanitary and insanitary houses a special handbook has been published, which will be preserved among the literature of the Exhibition, and which constitutes a small epitome of the ordinary defects of existing houses, and the simple means by which such defects may in future be avoided. I shall not enter into any description of these houses, for they are already well known to most of you, and may, I yet hope, be further studied on some future occasion. But I wish to draw your attention to the very important conferences on the sanitary arrangement of houses which were held

by the Institute of British Architects in connection with this part of the Exhibition, and especially to that held in the last days of the Exhibition by the Guild of Plumbers. This I call your attention to because there is good reason to hope that out of this will spring an organisation, and I trust a legislation, which will, perhaps, do more towards the preservation of health and the saving of life than most of the much more pretentious forms of legislation which we must contemplate in the near future. The Exhibition will, in virtue of the organisation likely to follow from this conference, become the means of drawing together all those scattered forces which have for some time tended in the direction of a great improved regulation of the sanitary condition of our houses: a force, however, which, up to that moment, there seemed but little hope of being able so early and so practically to organise. I feel a peculiar interest in this subject, for I have now for several years, as Chairman of the National Health Society, and in connection with the Sanitary Section of the British Medical Association, occupied myself with collecting the facts and figures which demonstrate the urgent necessity of improved legislation for the safeguarding of the sanitary construction of our houses, and the improved education and registration of those builders and plumbers to whom we intrust that construction. I read on this occasion at the opening of the Congress a paper which I had prepared three years before, and which, in fact, I have in various forms presented to several professional and lay bodies, with the view of forming and gauging public opinion on the subject. I shall venture to put before you here now only the conclusions which I laid before this Conference, which practically and in principle received their approval, and which will thus, I hope, have an earlier chance of finding their way into the statute-book. They have the object of strengthening our statute law as to drainage and plumbing. I desire to enlist the aid of the Society of Arts in bringing into legal operation, as one result of the International Exhibition, the proposals which will be found in the Report of the Conference, of substituting sanitary for insanitary houses.

First as regards drainage itself:—

(1) Rural authorities should have the same powers as are now possessed by urban authorities. In the suburbs of towns, just outside the municipal boundaries, thousands of houses are springing up without any sanitary supervision whatever. The rural authority is, perhaps, unaware of the evil, or is, at any rate, careless about it until the houses are erected; and their opportunity of making by-laws which can control such houses is then lost.

(2) It would be well that the requirements of the Model By-Laws as to New Buildings issued by the Local Government Board should be incorporated in a Building Act which should be forthwith passed, and be of general application throughout the country.

(3) The plumbing and drainage of all buildings, public and private, should be executed in accordance with plans and specifications previously approved in writing by the local authority.

(4) No drainage-work should be allowed to be covered or concealed in any way, until it had been examined and passed by the surveyor.

(4A) The efficiency of all drains should be tested by the peppermint or some other test before they are passed; and it should be a rule that, wherever possible, drain-pipes should be kept from view only by boarding which can be readily removed.

(5) No new house should be allowed to be inhabited until it had been passed and certified by the surveyor, and a plan of the system of drainage should be appended in every case to the lease or other document for the letting of the house.

As regards the plumbers, I suggest that—

(6) The names and addresses of all plumbers should be registered by the local authority, and no plumber should be able to carry on his trade until he had been so registered, and had received a license from the local authority.

(7) Before the license is granted to him the plumber should attend personally at the office of the local authority, for examination as to his qualification as a plumber.

(8) Such licenses should be renewed from year to year, and their continuance should depend upon the good behaviour of, and the return of the work done by, the licensee.

(9) The names of all licensed plumbers should be publicly advertised once a year by the local authority.

The result of this Conference will live. Before long, I think we may promise ourselves, we shall see, as one result of this Exhibition, an active movement set on foot by which we shall henceforth be enabled to train skilled and educated workmen, and to ascertain by suitable tests their efficiency, and by which we shall be enabled to protect our artisans and ourselves from occupying houses which have been built with a total disregard or flagrant defiance of the first principles of sanitary construction, and of the conditions which we all know to be primarily essential to healthy occupation.

The Health Laboratories.—I pass to the laboratories. It did not at first, I think, appear evident to some of the members of our Council how close was the connection between the work to be carried on in these laboratories and the public health. Happily, however, that feeling soon gave way to one of acquiescence in the proposition which I made for the establishment of these laboratories, and, since, a closer examination of the subject has, I think, convinced every one that it is to establishments of research and of study, such as those over which Mr. Watson Cheyne and Prof. Corfield presided, that we must look for the most solid foundations for future progress in solving the highest problems connected with the preservation of health; and that no part of the Exhibition fulfilled a higher purpose, and to none can we look with more assured hope in the future, than to these departments of the Exhibition. A description of the laboratories appears in the official catalogue, and I shall not occupy your time with any description of them.

At the Hygienic Laboratory, in its chemical and physical departments, the public were not merely given the opportunity of seeing hygienic analyses of various kinds going on, and of having them explained to them either by Prof. Corfield or his assistants, individually or in the form of popular demonstrations—of which a considerable number were given, chiefly by the senior assistant, Mr. C. E. Cassall, during the time the Exhibition was open—but they also had the opportunity of seeing the ordinary working of such a laboratory, from the fact that Prof. Corfield was able to utilise this laboratory for his students. A class of about forty teachers, seleeted by the Science and Art Department from schools in all parts of the country, attended a course of lectures given by him at the Normal School of Science, and at the same time worked in batches in the hygienic laboratory at the Health Exhibition, and thus the public were enabled to form an idea of what such a laboratory is in full working order; and, indeed, during the whole time that the Exhibition was open after the above-mentioned class had dispersed, there were pupils who worked in the laboratory.

In a complete hygienic laboratory there should be a separate part set aside for physical experiments relating to hygienic appliances; but in this laboratory there was barely space for the chemical work to be carried on, and even the microscopical work could only be prosecuted to a limited extent, insomuch that the class of teachers went through their course of microscopy relating to hygiene in the physical laboratory at the Normal School, and the absence of physical appliances was replaced, as far as it could be, by demonstrations given by Prof. Corfield at the sanitary and insanitary houses.

As regards the Biological Laboratory, it is sufficient for my purpose to-night to remind you that in it Mr. Cheyne, the worthy pupil of Sir Joseph Lister, who acted as chairman of the Laboratory Sub-Committee, showed by practical working, and by collections such as had never before been seen in this country with the same completeness, the refined methods of research and of teaching by which we are enabled to study the life-history and the habits, the development and the means of arresting the development, of those minute organisms which modern science has shown to be prime factors in the causation of a great proportion of the most fatal diseases which afflict our flocks and herds, which decimate mankind, and which attack those plants and animals which constitute the staple of our food-supplies. Mr. Cheyne's demonstrations were eagerly followed by health students from all parts of the kingdom. A certain number of tables were set apart for study and research, and these were fully occupied from the first to the last days that the Exhibition was open. In Dr. Corfield's laboratory was collected the apparatus for that kind of instruction in the chemical and physical examination of soil, air, water, food, clothing, and materials of house construction, which are essential elements in the education of that great army of medical officers of health who are appointed now under existing Acts of Parliament to watch over the health interests of the community. It is very well known, however, that a large majority of those gentlemen have not this necessary instruction, and that at the present moment there does not exist in this country any adequate means for giving such instruction. There are in England 1102 medical

officers of health, and 996 inspectors of nuisances, all of whom are expected to get their information and to acquire the technical knowledge of which they stand daily in need as best they can; and it is well known that a large proportion of them are very imperfectly equipped with the necessary knowledge, and indeed can hardly be said to possess even the rudiments of systematic technical education in subjects in which they are presumed to be experts, and which they are called upon to decide in matters largely affecting the pockets of the community and intimately concerning its health. In order to illustrate the importance of the establishment in this country on a permanent footing of such laboratories as those which were shown in temporary working at the Exhibition, I shall ask leave now to refer you to an exhibit which was made in the French Court, illustrating the work done by M. Pasteur in a similar laboratory to that of which I am now advocating the permanent establishment, as the best possible sequel of this great Exhibition.

M. Pasteur is the scientific director of the École Normale supérieure in Paris, a school especially designed to supply professors in literature and science to the *lycées* or higher schools of France. He is not, however, called upon to undertake teaching, but is expected to devote all his time to his researches. In a word, in consideration of the considerable national services which he has rendered, an exceptional position has been accorded to him. He receives a professorial salary of 400*l*. a year. M. Pasteur is also the head of l'École des Hautes Études, of which Mr. Chamberlain is the sub-director. In this laboratory he receives some pupils. He possesses further a laboratory at the École Normale, where M. Roux is his coadjutor, and where are admitted some students who are generally persons already known for their studies. He has entire freedom of the choice of students of the laboratory of l'École des Hautes Études, as well as those of persons who work in his private laboratory at the École Normale. About 800*l*. a year are allowed for this laboratory by the Minister of Public Instruction, and for the last few years, 30,000 francs from the Minister of Commerce and Agriculture. These grants are renewed yearly.

The principal researches of M. Pasteur have related to—

(1) *Wine*, in which he demonstrated that, in order to avoid the transformation of alcohol into acid, it is necessary to destroy the germs remaining in wines which are poor in alcohol, by heating them up to 55°-60° Centigrade. He has also studied the action of oxygen and light on wine, and has demonstrated that it is to this action, *i.e.* to the oxidation of the materials of wine, that we are to attribute the development of the bouquet of wine, *i.e.* the flavour which it acquires with age. In order that this may yield a product appreciated by amateurs, it is necessary that it should proceed slowly. He has further demonstrated that the ferment of wine exists on the surface of the grape when it has ripened. He has demonstrated the useful and precise indications which the areometer furnishes, in order to appreciate during fermentation the state of the *mout* of the grape.

(2) *Beer*.—After having demonstrated that brewers employ, generally, a ferment containing, among others, injurious germs, M. Pasteur indicates the following means for obtaining a pure ferment. A small quantity of pure yeast is prepared according to the exact rules of the laboratory. This is introduced into a large copper pan, three-quarters filled with the wort of beer, which has been first carried to the boiling-point, and then cooled before the introduction of the yeast. The vessel only communicates with the external air by a long tube of copper, many times bent, in such a way as to permit the gases to escape without external germs being able to enter. When the wort has been developed, it is drawn off by a tap placed in the lower part of the apparatus, and which is previously purified with the flame of a spirit lamp. The wort of the beer is put to ferment in a large white-metal vat, resting on a plank, and closed by a movable cover, this movable lid dropping into a groove which is kept full of water. As the wort arrives in a boiling state in this vessel, it destroys any germs which may exist there. When it is cooled, and the cooling may be rapidly aided by the use of external cooling water, the yeast is introduced through an opening in the lid. The aëration of the fluid is obtained by two tubes curved downwards, by one of which carbonic acid escapes, and by the other the air enters after being previously filtered through a layer of cotton wool rolled round a cylindrical cage on metal wires which cap the extremity by which the air enters. This apparatus, like the foregoing one, reproduces exactly the conditions which are found to be necessary in the laboratory to prevent the introduction of external germs. The aëration by these two tubes is sufficient, for the carbonic oxide being heavier than air, they are placed in such a way as to form a siphon; moreover, during the fermentation, the wort is certainly kept in movement by the ebullition of the gas which escapes, so that the aëration, although less active than in some of the technical apparatus previously in use by brewers, is more than sufficient. By employing this procedure, secondary fermentations are no longer to be feared, and the spoiling of beer by secondary fermentation is almost entirely put an end to.

(3) A third and profoundly interesting series of researches, which have had a great influence on agriculture, carried on by M. Pasteur, are those relating to *charbon*—the malignant pustule or black quarter of cattle and sheep. M. Pasteur has demonstrated that animals of the ovine and bovine species may be prevented from contracting the disease of *charbon* by inoculating them with attenuated germs, obtained by artificial cultivation of the specific minute organism which is ascertained to exist in the case of *charbon*, and to be the efficient cause of the disease. This attenuated preventive material for inoculation is obtained by the aid of what are known as cultivations of the germs made in special liquids. After the first inoculation with the highly attenuated virus, Pasteur has shown that the second inoculation may be made with a product of medium virulence, and that the animals thus twice vaccinated were unsusceptible of contracting the disease. Pasteur has further demonstrated that the bacterium of *charbon* is capable of retaining its vitality for several years in the earth, and that, when brought to the surface by earth-worms, it is capable of infecting the animals which eat the grass polluted by its contact, especially if the grasses or plants so eaten be hard, and such as to cause abrasions in the mouth and digestive tube.

(4) *Silkworm Disease*.—M. Pasteur, after having assured himself that normally, and in good health, silkworms never contain, at any moment of their life, the bacteria or corpuscles seen for the first time by Guérin Menneville, demonstrated that the eggs of the worms, even when only slightly attacked, contained a great number of these corpuscles or bacteria, which developed in considerable quantities when the animal underwent its metamorphoses, and finally destroyed it. Since its droppings polluted the leaves of the mulberry on which the silkworm feeds, and as healthy animals thus devoured them, and contracted the same disease, a single infected silkworm was capable of destroying a whole school of worms, and preventing the subsequent cultures from being developed.

M. Pasteur then laid down the rule that, in order to avoid the silkworm disease, it was necessary to choose with extreme care the animals which were to be employed for breeding. With this view he devised the following procedure:—When the female has laid its eggs it is at once destroyed. If a single corpuscle is found in its tissues, when crushed in water, the eggs are immediately burned. In the same way the several eggs of each hatching are carefully examined. If no corpuscles are discovered, the whole brood is preserved for culture; if any are found, the whole are immediately destroyed. Since that time the silkworm breeders have followed the rules of M. Pasteur. The implements for the purpose of recognising the diseased worms consist of a microscope, two objectives, one with low power, and one with high power, magnifying about 400 times, and a small porcelain mortar for crushing the tissues of the worm or its eggs, some glass slides, and a flask of distilled water. By this application of scientific research to the silkworm industry the silkworm disease has been almost wholly put an end to. Nearly all the silkworm growers, whether masters or servants, have learnt, by the aid of a very cheap little handbook, prepared by M. Pasteur, to recognise diseased worms or eggs from healthy eggs or worms, and thus a great industry, which was threatened with extinction, has been saved from the fate which threatened it.

(5) *Fowl Cholera*.—After having demonstrated that this affection is caused by a micrococcus, M. Pasteur showed that if this micrococcus is cultivated in the manner which he indicates, and the micro-organism thus obtained inoculated in a fowl, the fowls so vaccinated become proof against fowl cholera, even when they are placed in the midst of other infected fowls. These researches have a special and suggestive scientific interest, for he has shown that if you filter through plaster the liquid taken from one of the external foci of the disease in a fowl affected with fowl cholera, the filtered liquid thus inoculated will not give a healthy fowl the specific disease, but render it somnolent

and inert for some hours, so that it may be concluded that the micro-organism secretes a material to which must be attributed the lesions which are observed in fowls suffering from fowl cholera.

Some idea may be obtained of the commercial value of the work done by M. Pasteur in his laboratories from the following facts and figures, which I have on good authority:—In three departments of the centre of France, after the silkworm disease had attacked the factories, the product yielded a value of less than 1,500,000 francs. Since the regulations laid down by Pasteur have been applied, the average value per annum, calculated on five years, in those departments has risen to more than 22,000,000 francs.

As to wine, there was a known loss of wine to the extent of 1,700,000 francs in four departments. Since heating on Pasteur's method has been applied, there has been saved of this loss at least 1,500,000 francs; the difference of 200,000 francs being alleged to be due to the carelessness or ignorance of small proprietors, who are unwilling to heat their wine. As there are in France about forty-five departments that make wine, the saving may thus approximately be estimated. I should add that there are twelve departments that make silk.

In respect to anthrax, the following was the official statement indicating the ravages made by this disease in France and foreign countries, and the reduction of mortality effected by these inoculations:—

1881	Sheep	Oxen	Horses
France	62,050	5977	142
Foreign countries...	12,500	1254	100
Total	74,550	7231	242
1882			
France	270,040	35,654	1825
Foreign countries...	36,830	6,169	200
Total	306,870	41,823	2025
1883			
France	268,205	26,453	371
Other countries ...	84,825	5,777	975
Total	353,330	32,230	1346

The average mortality reduced by these inoculations in the proportion of 10 to 1 for sheep, and 15 to 1 for oxen, cows, and horses.[1]

Meteorological Laboratory.—The corresponding exhibit was that of the meteorological laboratory by M. Miquel, corresponding to which I hope to see a permanent meteorological station established as a sequel to the Exhibition. The work of M. Miquel has been summarised in the following words by Dr. Vivian Poore:—The observatory for Montsouris was established, in 1871, by the influence of M. Dumas, who was then President of the Municipal Council of the city of Paris. In 1873, M. Marié Davy was appointed director of the observatory by M. Thiers. The work of the observatory is as follows:—

(1) Meteorology proper, and its application to agriculture and hygiene. This department is under the control of M. Léon Descroix.

(2) Chemical analysis of the air and rain, under the control of M. Albert Lévy.

(3) The microscopic study of the organic matters held in suspension in the air and rain. This is under the control of M. P. Miquel.

In 1876, the municipality decided to have the above meteorological observations, in their relation to hygiene, made in different parts of the city. The chemical analyses and microscopical examinations are made—

(1) On drinking waters.

(2) On the waters infiltrating the soil.

(3) On the emanations from the soil and sewers.

(4) On the air of different localities estimations are made. A. (air), ozone, carbonic acid, ammonia, organic nitrogen; and similar analyses are made of the soil-water, &c. Every year the *Annuaire de Montsouris* is published, a work full of information, and which is now in its thirteenth volume.

The laboratory of Mr. Cheyne at the International Health Exhibition was largely fitted up by the aid of Dr. Koch, and of Dr. Koch's laboratory at Berlin. Mr. Cheyne has furnished me with the following outline:—

Dr. Koch's laboratory is subsidised by the Government. It consists of director, library, biological department under Dr. Koch and several assistants, and a chemical department. All expenses of investigation are paid. Koch's salary is only 300*l*. Other salaries I do not know. When appointed, Koch first set to work to improve methods of cultivating and studying bacteria, and to devise new methods, and the result has been a precision and simplicity in this sort of work quite beyond all expectation. His further researches have been devoted to the study of the cause of disease in man and how to prevent it. Either by himself, or under his direction, the causes and means of prevention of tuberculosis, consumption, erysipelas, osteomyelitis, and glanders have been absolutely demonstrated, while a large amount of work has been done in respect to the causation and prevention of typhoid fever, cholera, diphtheria, and other affections. His researches on disinfectants and the best mode of disinfection are classical, and are still being carried on. This work is being rapidly extended to other diseases, while important researches are going on relating to water, air, and soil.

The Anthropometric Laboratory at the Health Exhibition was designed by Mr. Galton, to show the feasibility of performing, at a small cost, an extended series of measurements of the human faculties, and of testing the demand that there might at present be for having such measurements made. The ulterior object he had in view was to familiarise the public with the facility and need of periodically recording facts which test the progress of individual growth and development, whether it is proceeding normally or otherwise; and if it should be abnormal, to call attention to the existence of hurtful influences, and to demand inquiry into their nature, and whether they may not be removable. The experience of the laboratory showed emphatically, first, that about seventeen different measurements of each person, including height, weight, strength, breathing capacity, eyesight, judgment of eye, hearing powers, &c., could be accurately performed at a cost of less than 3*d*., by means of a well-organised method of work; secondly, it showed that the public greatly valued the opportunity of having themselves measured and appraised in so minute a manner, inasmuch as the door of the laboratory was besieged all day long by a crowd of applicants for admission, far more numerous than could be accommodated in its small area, 36 feet long by 6 feet wide. As it was, measurements were made of between nine and ten thousand persons, yielding data that are now being discussed, and which have considerable statistical value. The methods and appliances used and suggested by the experience of this laboratory have been very recently described by Mr. Galton at the Anthropological Institute. It is therefore not necessary here to go into details. It may be taken as established that there need not be the slightest difficulty in periodically measuring with much completeness and keeping a register of the development of every boy and girl in large schools, at the cost of a very few pence per head per annum, on the supposition that the process was methodically conducted by a paid expert, with the willing and gratuitous assistance of the masters and attendants. The power of a system of periodical measurements and tabulated returns upon the well- or ill-being of the growing portion of our race is of unquestionable value, and it would seem that common-sense considerations must insure its being ultimately called into action. Now that there are signs of much awakening to the importance of such records, a central institution becomes especially desirable, where the best patterns of instruments should be kept, where instruction in their use might be obtained, where the methods of tabulation, and of quickly getting useful results out of the data, might be learnt, and where the fullest information of all kinds on anthropometry would be stored. It must not for a moment be supposed that anthropometry is a simple and thoroughly understood art. On the contrary, it continually grows, new methods being discovered from time to time of measuring faculties that had before escaped measurement. There can be little doubt that the progress of the useful art of knowing one's self all round, and of knowing others accurately, of reducing what has hitherto been too much a matter of estimate to quantitative measurement, would be very largely aided by the establishment of an anthropometric laboratory in a national hygienic institution.

Proposed Disposal of Surplus.—That which I look forward to, then, as the best possible sequel to this Ex-

[1] In the last thirty years there has been an increase of life-duration of from 39·9 to 41·9 years, an increase of 5 per cent. human duration of life. The annual economy of life, on the least favourable calculation, during the last five years, has been equal to a saving of 36,000 lives per annum. The money saving on the last five years has been calculated, on good basis, by Capt. Galton, to be in London alone nearly half a million of money per annum.

hibition, is the establishment of these laboratories, so vastly important to the prevention of disease and the maintenance of our population in health, and of the library on a permanent footing and under suitable direction. The whole subject is one on which I can only venture to express, thus far, my individual opinion, although I have the satisfaction of knowing that the views which I have thus put forward have met with considerable approval among many of my colleagues, to whom I have submitted them *in limine* for future consideration by the Executive Council, who may possibly approve of them, and in that case may feel it their duty to submit them to his Royal Highness the President, with whom will rest the ultimate decision as to the disposal of any parts of the surplus. The rumour that such a project was about to be submitted to the Council, has awakened the liveliest interest and satisfaction amongst the authorities of the leading sanitary associations in this country, and I am glad to know that the authorities of the Parkes Museum, of the Sanitary Institute, of the Social Science Association, of the Society of Medical Officers of Health, and of the National Health Society, have each, on their own individual motion, taken the opportunity of expressing, by resolutions and memorials, their strong sense of the great national value which they consider would attach to the accomplishment of this design. Should this proposition prove acceptable to the authorities, there is no doubt that the opinion of the great body of persons interested in the sanitary progress of this country, thus early expressed by the official representatives of every form of sanitary progress, would declare itself strongly in favour of an institution from which considerable results might be anticipated in the furtherance of health education, and of our knowledge of all that relates to the prevention of disease. It is further hoped that an Institute of Public Health, founded on this basis, might prove a home and centre with which these numerous voluntary organisations now working for the public health might connect themselves, by some well co-ordinated and accepted plan; that it might be a centre where their members would be able to meet; where libraries, class-rooms, and meeting-rooms might be made to serve a valuable purpose in bringing these various societies into closer relation. There is reason to hope that many of the great scientific associations which now foster the progress of science by grants to individual workers, would heartily welcome the establishment in this country of what it so greatly stands in need—a place of higher education and research in sanitary science, such, as I have already pointed out, as have been recently created in France and Germany. England has been first in sanitation; it is here that have been solved—so far as they have as yet been solved—many of the greatest problems of sanitary science; but we must acknowledge that, during the last decade, each of these countries has made progress in the higher departments of sanitary education and sanitary research, in which we can hardly be said to have held an equal place. This reproach we may now find the means of wiping away, and I earnestly trust that this may prove to be a sequel of the International Health Exhibition, than which no higher memorial could have been hoped for or expected.

The Lesson of the Exhibition as to Open-air Recreation and the Electric Lighting of Public Parks.—Let me conclude by reference to another aspect of the teaching of the Exhibition, less scientific, but yet of peculiar public importance. It was often said by the public scorner—a person from whose judgments and criticisms we have commonly much to learn—when walking through the crowded course of the Exhibition devoted to food and all that concerns the construction and decoration of the dwelling: "This is a Health Exhibition—where is the health?" and the popular answer was, "Outside in the gardens." That answer also I accept. I think you will agree with me that the practical demonstration which this Exhibition afforded of the eagerness of the English people to resort to healthful means of outdoor amusement was in itself a valuable result and an important experience. The gardens, illuminated by the electric light and enlivened by music, were undoubtedly a great attraction to the Exhibition, and I would be quite willing to agree with any one who might say that they were the greatest attraction. Allow me to add that I look upon this not merely as a means, but itself an end. It is no small thing to have acquired the conviction that our open spaces may be, and should be, much more largely devoted to the open-air recreation of the people than they are at the present moment. I say this now, without any intention of entering upon that large question, but with the specific desire to repeat (for it is only by repeating often that one can gain access to the minds of the majority who are all-powerful in such questions) that it appears to me to be no small disgrace to this great metropolis that, in the very centre of its crowded districts, within an arrow's flight of the houses probably of most of us who are here, there lie great open spaces, such as Hyde Park (but what I say refers also to Victoria Park), which at night are dreary desolate areas of darkness, which are unlighted, which are dangerous to cross, which are unused in the evenings for any wholesome or moral purpose, which are often scenes for the display of some of the worst vices incidental to the lowest dregs of the population of the great city. Why should we not learn from the success of the music and the lighting of the gardens of the Health Exhibition, that our great parks should all be lighted by the electric light at night, and that throughout the spring and summer months the military bands should play there, and should make those places, which are now not only useless but scandals to the metropolis, the sites of healthful and innocent recreation? I have inquired from a good source what would be the cost of lighting Hyde Park by the electric light; and I am not speaking without data when I say that I believe that Hyde Park could be adequately lighted with the electric light, so that it might add to the resources of health and enjoyment for the teeming population surrounding it, at an annual expenditure of about 5000*l*. I do not know what impression this will make upon you. I confess that to me such an expenditure seems trifling in consideration of the sum of human happiness and enjoyment, and, I may add, also of health, which such a devotion of municipal or public money would afford to the people of this city. Nor is it likely that, the example once set, it would end here. Our eastern population have a right to the enjoyment of their parks in the evenings that could be conceded to the west. This lesson also, then, the Exhibition seems to me to teach, and how greatly we might all rejoice if it should ultimately prove that the lighting by electric light of our public parks, and the introduction of music as a part to enliven and attract the people, and to add to the success of the innocent recreation, the health and the happiness of our working population should form also one of the possible sequels of this Exhibition.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—Prof. Roy was on Thursday last admitted to the degree of M.A. *honoris causâ*. The Public Orator in presenting him spoke as follows:—

Dignissime Domine, domine Procancellarie, et tota Academia, —Quis nescit Athenas illas Caledonicas, cum aliarum artium, tum praesertim studiorum medicorum praeclaram esse sedem. Academiae tam illustris alumnum, Pathologiae Professorem primum nobis nuperrime datum, hodie senatus totius nomine salutamus, ipsum senatorum nostrorum ordini libenter adiungimus. Neque vero una tantum doctrinae sedes Professorem nostrum sibi vindicat; scilicet Germaniae ipsius Academiae celeberrimae hunc virum inter alumnos suos numerant. Ne inter Cantabrigienses quidem prorsus hospes est, qui non modo Physiologiae praeceptoris nostri optimi experimentis aliquamdiu interfuerit, sed etiam ipse de Physiologiae arcanis praelectiones quasdam inter nosmetipsos habuerit. Idem quondam (ut ad remotiora transeamus) Ottomannorum inter milites arti medicae deditus, in ipsa Epiro, prope Pindi montes, prope Dodonae antiquae diu desertum oraculum, velut ἰατρόμαντις aliqui, consulentibus respondebat. Ad eundem postea Respublica Argentina, morbo gravi et inexplicabili oppressa, velut ad oraculum aliquod misit, cuius responsis obsecuta peste illa dira sese protinus liberavit. Inter antiquos quidem victimarum in visceribus rerum futurarum praesagia quaerebantur; hic autem, non vanus haruspex, ex ipsis morbis quos alii reformidant, ex ipsa Morte quae aliis tacet, veritatem ipsam audacter extorquet,—adeo ut Catonis verbis profiteri possit:

me non oracula certum
sed mors certa facit.[1]

Vobis praesento Medicinae Doctorem Edinensem, Pathologiae Professorem Cantabrigiensem, CAROLUM SMART ROY.

[1] Lucan, "Pharsalia," ix. 582.

SOCIETIES AND ACADEMIES

London

Physical Society, November 22.—Prof. Guthrie, President, in the chair.—Mr. James Bewsher was elected a member of the Society.—The following notes were read by Mr. R. T. Glazebrook, M.A., F.R.S.:—On the permanence of some standards of electrical resistance. The author has had occasion to compare with ten standard B.A. units a coil which had been tested by Lord Rayleigh in 1882, the coil then being two years old. He found that its resistance was 9·98335 B.A. units at 14°·05 C., while Lord Rayleigh found the value 9·98330 B.A. units. Thus, either the coil and the standards have changed by exactly the same amount, which is improbable, for they are wires of different thickness, or they have all remained permanent.—On the effect of moisture in modifying the refraction of plane-polarised light by glass. The author described some experiments he had been engaged in lately at the Cavendish Laboratory. Plane-polarised light is made to fall on a plate or a wedge of glass at various angles, and the position of the plane of polarisation determined. It is found that this depends greatly on the hygrometric condition of the air in the neighbourhood of the glass. If moist air be blown on to perfectly clean glass, the plane of polarisation of the emergent light is displaced from its normal position in one direction, while, if dry air be blown, it is displaced in the opposite direction. At an angle of incidence of 60° the difference between the two positions is from 6′ to 8′. If, however, the glass be not perfectly clean, the effect of moisture is *at first* the same as that of dry air, though on stopping the draught an opposite effect is observed. The author assigns as the cause of this the heating of the surface, which, as Magnus discovered, is produced by a draught of moist air. He finds, on repeating Magnus's experiment, that the heating is not produced if the glass be clean, and he shows by an independent experiment that slight local heating does produce an effect on the plane of polarisation in the same direction as that due to the dry air.—Mr. Glazebrook also exhibited a spectrophotometer described by him in a paper read before the Cambridge Philosophical Society (*Proc. Phil. Soc.* vol. iv. part vi.), and made by the Cambridge Scientific Instrument Company from his design.—A note on a point in the theory of pendent drops, by Mr. A. M. Worthington, was read by the Secretary, Mr. Walter Baily. This was a note upon a paper recently communicated by the author to the Royal Society upon the measurement of the surface-tension of a liquid from the observations of the forms assumed by pendent drops. By making a measurement of a horizontal section of such a drop, and of the angle made by the tangent plane to the surface at the line where the section meets the surface with the horizontal, and knowing the density of the liquid, sufficient data are obtained to determine its surface-tension. Prof. Perry remarking upon this paper gave an account of some researches upon the subject, in which some years since he had assisted Sir William Thomson. On the usually accepted theory of surface-tension based upon the behaviour of liquids in capillary tubes, at every point of the surface of a liquid the equation

$$kp = \frac{1}{R} + \frac{1}{R'},$$

must hold where p is the pressure at that point or the difference of pressure on the two sides of the surface, R and R' the two principal radii of curvature, and k a constant. In the case of a drop whose surface is one of revolution about the vertical, the contour may be drawn from the equation. This was done, and theoretical drawings were made of a number of drops. These have since been compared by Sir W. Thomson with enlarged photographs of actual drops, and the results are highly satisfactory. This law no longer holds in the case of a drop at its "critical point," or that point when it is about to fall, since here dynamical action comes in.—Mr. Baily also read a paper by the same author on a new capillary multiplier. This is an apparatus for the measurement of surface-tension, and is a modification of one used by M. Despretz. From one extremity of the arm of a balance is suspended a roll of platinum foil, consisting of a strip 50 cm. long and 5 cm. or 6 cm. broad, rolled up, the successive convolutions being prevented from touching by rolling up with the foil a number of small pieces of hard glass tubing about 2 mm. diameter, which occupy the upper part of the helix, and preserve the form of the lower. The coil is cleaned by igniting it in a Bunsen flame, and then suspended with its lower end in the liquid to be examined. The increase in weight corrected for the part of the coil immersed is due to the fluid rising between the convolutions. From this the surface-tension is readily calculated.—Mr. Hilger described a new solar eye-piece. In Prof. Pickering's eye-piece there are two rectangular prisms of glass of slightly different refractive indices. The light of the sun undergoes partial reflection at the surface separating the two prisms, the ratio of the reflected to the incident light diminishing with the difference between the refractive indices. It is found, however, that such a prism under a high power always gives a double image, due to the two glass surfaces, it being practically impossible, even under enormous pressure, to bring them into true contact. To obviate this Mr. Hilger makes the second prism of Canada balsam, which gives the most satisfactory results, the image being pure and single.

Vienna

Imperial Academy of Sciences, November 6.—On the fossil flora of the breccia of Hoetting, by C. von Ettingshausen.—On resorcin-blue, by P. Weselsky and R. Benedikt.—Carcinological notes, by K. Kœlbel.—On a reduced organ in *Campanula persicifolia* and in other species of Campanula, by E. Heinricher.—A new method of combating Phylloxera, by G. Henshel (sealed packet).—Contribution to the anatomy of the male organs of generation, by E. Finger.—On the bodies formed from hydroquinones by melting soda, by L. von Barth and T. Schreder.—On the temperature of the Austrian Alpine countries (part 1), by E. Hann.—On oxyphosphinic acids, by W. Fossek.—On the length of the year of Sirius, by Th. von Oppolzer.—On the figure of light-waves in the magnetic field, by E. von Fleischl.—On diluvial man from the caves of Stramberg (Moravia), by T. N. Woldrich.

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THURSDAY, DECEMBER 18, 1884

A TEACHING UNIVERSITY FOR LONDON

A MOVEMENT, which first began to shape itself into form at the Educational Conference at the Health Exhibition, made its first formal public appearance at the house of the Society of Arts on Monday afternoon. The crowd of well-known and much-occupied men with which the room was filled was at least an earnest of something more than a discussion of a mere speculative project; and the speeches made, though revealing, as might be expected, a considerable diversity in point of view, were listened to with a closeness of attention which indicated a pretty confident belief that the movement was not likely to evaporate in mere debate.

Lord Reay opened the proceedings with an address, which was admirably conceived both in tone and matter. If subsequent speakers scarcely can have been said to have carried on the discussion on the same level, this may be attributed to the fact that the report submitted to the meeting for adoption by Lord Justice Fry embodied an amount of detailed suggestion which the meeting was naturally not in any way prepared to assimilate without a good deal of consideration.

Every one knows that we have in London a body bearing the title of a University. Every one, at least who has looked into the matter, knows equally the immense services which this institution has rendered in raising the standard of middle class education. But a University all the same, in any intelligible sense, it is not. It is essentially nothing more than a Government Department for giving, after examination, academic certificates. Nor, as Professor Lankester very properly pointed out, is it, any more than the Home Office for example, an institution which, because its head-quarters happen to be in London, is locally identified with the metropolis in the same sense in which the Universities of Oxford and Cambridge are identified with the places in which their work is carried on. The operations of the University of London are, in point of fact, more wide-reaching than those of any other Government office, and are, indeed, co-extensive with the Empire itself.

In one aspect the whole movement may be regarded as an outcome of the nascent municipal feeling in the life of the metropolis. The Examining University, for reasons stated above, does not, and in its present form never can, satisfy the reasonable desire that the metropolis should possess that academic crown which is worn by every other great capital in the world. The disembodied spirit of what might be brooding over gloomy examination halls may strike a wholesome terror into the hearts of candidates, and sustain a certain feeling of emancipation in the hearts of candidates; but it cannot, and does not, excite any enthusiasm in either. Nor has the cold officialism of Burlington Gardens ever treated with more than a lofty disdain the more humanly organised institutions which furnish the victims who pour into its portals.

The movement to constitute a Teaching University is undoubtedly in some degree due to a reaction against this state of things. Those whose business "is to teach, know now-a-days that a great deal depends on the way teaching is done. It is here that the educational bodies of the metropolis feel their isolation. There is no central authority to gather their representatives into its fold and smooth away the individual difficulties in the way of common action and" bringing into harmonious cooperation the dual business of examination and teaching. Life is getting appreciably shorter now; the thread of existence has more knots though its length remains the same. The time that can be given to education out of an ordinary existence cannot be indefinitely expanded. Method must be brought in to economise labour in instruction. This is a very different thing to cramming; it is on the contrary a scientific mode of directing the educational attack in the most effective way. Here the rulers of the University have shown themselves most deficient in sympathy; they have turned an obdurately deaf ear to the entreaties which have been repeatedly addressed to them by the Convocation of the University to get "touch" with the teaching bodies. And, what is perhaps even still more irritating, though, as remarked at the meeting, for the most part, laymen in education, they still issue in a purely *doctrinaire* spirit directions which of course from the nature of the case have the binding force of edicts at the actual seats of education. Dr. Carpenter, with an official optimism excusable enough in one who has devoted a lifetime to loyal and honest work, contended, it is true, that the university was blameless in this respect. But those who are familiar with the other side of the shield know how far this is from being the feeling in teaching institutions. Manchester has already broken away from the rule of Burlington Gardens, and it can scarcely be doubted that had the University of London shown a more conciliatory attitude with regard to the formation of Boards of Studies, the present movement would in all probability have taken a very different shape.

It is proposed, then, alongside of the existing examinations to have a Teaching University. This it is also intended should examine and grant degrees. It may be thought that this is going too far, and that it is not desirable that the one thing should become a mere mechanical reflection of the other. But the risk is small; the principle is now-a-days accepted by all who have really studied the matter, that teachings and examinings must be in the hands of the same persons; but this does not imply that the same individuals should control both. Nor, it must be admitted, is this merely a matter of interest to the teaching bodies. The imperfect educational discipline to which a large proportion of the candidates who frequent the examination rooms of the university have been subjected, leads to an inordinate amount of rejections. This creates the misconception in the public mind, that the examinations are unreasonably severe. The real fact is that the candidates are badly prepared. In this way the want of cooperation between teachers and examiners becomes indirectly a real obstacle to educational progress.

So far we have endeavoured to give our readers an account as distinct as we have been able to gather of the forces which have initiated this movement, and the aims which are desired by it. We cordially sympathize with both, and it is because we do so that we must now indulge in a little criticism on the scheme as put forward by Lord Reay's committee. In the first place, we found it difficult

to believe that the creation of a new university with full powers in the metropolis is ever likely to come within the bounds of political possibility. It is not that the Government will be inaccessible, but that it will be difficult to persuade general public opinion of the necessity of such a course. We believe that it will in the end be necessary eventually to come to terms with the existing university. The fact that eleven members of its Senate have joined the movement, shows that that body at any rate contains a powerful element discontented with its present asphyxiation by red tape. What, however, we do hope to see is the federation of our scattered educational bodies in London into Faculties, which would be practically universities in all but the name, and the representatives of which should have a leading voice in the management of the Central University. The only speakers who really evinced at the meeting a clear idea of their own policy, were the representatives of the Medical profession. Prof. Marshall showed with singular lucidity that the altered character of medical education has made the continued isolation of the smaller medical schools a practical impossibility. Not merely has technical instruction gone beyond the capacity of the junior members of the medical staff who are usually told off for it, but the appliances required are too costly for all but the wealthier schools to provide efficiently, and the teachers are themselves wanted for the more minute and careful clinical instruction which is now everywhere demanded.

The Medical Schools will therefore combine, perhaps, into some four great groups, for purposes of education and the organisation of laboratories, just as the small colleges at Oxford and Cambridge have combined for purposes of intra-collegiate lecturing. Once federation has begun, the foundation of a medical faculty for London is only a question of time. This will come about, probably, whatever the fate of the more general movement. But such a faculty would undoubtedly be found to be politically a body to whose just claims in direct medical education the University of London would find it impossible to lend a deaf ear.

The faculty of law may also shape itself into existence, though, it must be admitted, the elements of its form are, at present, very dim and shadowy.

To balance these we want a faculty of literature and science, and the materials for these are to be found in a federation of University and King's Colleges, as suggested by Prof. Lankester. If the representatives of such a faculty were allowed a proper share in the councils of the existing University, it is not obvious why such a federation should be intrusted with a separate degree-giving power.

We now come to what appears to us the weak point in the scheme. A university may impart knowledge; it may test its quality when imparted; but that which has ever been the peculiar glory of university life, is to enlarge its bounds. But except a few well-expressed sentences which fell from Lord Reay, and a sentence put into the conclusion of the report very much with the air of an afterthought, this very important matter does not seem to have received very much attention. Now the most melancholy feature about such elements of university organisation as already exist in London, is its displayed incapacity to retain its best men. There is an obvious dearth of such posts as would satisfy their legitimate ambition. No sooner amongst us does a man rise to the first rank at any seat of education, than sooner or later he is drafted off to one of the universities in the provinces. To take the first instances that come to hand: Cambridge has robbed us of Michael Foster, and Oxford of Burdon Sanderson, while the greatest biological teacher of the day is driven from England by ill-health after a life toilsomely spent in the lowest order of teaching—drudgery. What is absolutely essential to add lustre and distinction to the work of a Metropolitan University is a body of University Professors who would take charge of the higher studies, which never can be properly cared for by bodies sedulously occupied with the very serious business of the higher education. What we hope then some day to see is the University of London equipped with a proper staff of Regius Professors, who themselves would be at the least an invaluable bond of union between its own too abstract isolation and the living reality of the actual teaching bodies.

Although we could have wished for greater insistence on this—as it seems to us—most vital point, we cannot but entertain the highest hopes of the usefulness of the present movement. It has some of the notes of healthy organic development; it has at least spontaneity and individual activity, which have always been the foundations of political achievement amongst us. At the worst, mere effervescence is better than stagnation, and we think there is more in this movement than effervescence. In any case we cannot too warmly tender our expression of acknowledgment to public men like Lord Reay and Sir George Young, who have spared neither pains nor labour in the purely patriotic labour of giving our own too inarticulate murmurings definite form and expression.

THE POLYZOA OF THE "CHALLENGER" EXPEDITION

The Zoology of the Voyage of H.M.S. "Challenger." Part XXX. "Report on the Polyzoa—the Cheilostomata." By George Busk, F.R.S., V.P.L.S., &c. (Published by Order of Her Majesty's Government, 1884.)

THE description of the Polyzoa collected during the expedition of the *Challenger* was undertaken by Mr. Busk, and the first part of his Report, comprising the Cheilostomatous forms, or those in which the mouth of the zoœcium or cell is provided with a movable lid which shuts down over the polypide when retracted, has just been published.

The investigation of this important part of the *Challenger* collections could not have been placed in better hands. As an authority on the zoology of the Polyzoa, Mr. Busk stands pre-eminent; and the present admirable Report of 216 pages and 36 plates bears testimony to a laborious and conscientious investigation, the value of which as a contribution to our knowledge of the multitude of forms associated under the name of Polyzoa cannot be over-estimated.

The number of species of Cheilostomatous Polyzoa in the *Challenger* collection is 286, and when these came into Mr. Busk's hands he found no less than 180 of them

new. In one genus alone, that of the *Reteporæ*, the number of known species has been raised by the dredgings of the *Challenger* from 31 to between 50 and 60.

The determination and definition of species in a collection so large as that of the *Challenger* Polyzoa, and in a group of organisms in which the differences are far from being always strikingly obvious, cannot but be a work of great labour. The critical examination of the species in such a genus as *Retepora*, for instance, which is represented in the *Challenger* collection by 23 species, and *Cellepora*, which is represented by no fewer than 31, requires no ordinary patience, and the author must be congratulated on having so far brought to a conclusion labours which, in order to be conscientiously performed, must be often wearisome and monotonous.

Among the most important contributions of the Report to the systematic zoology of the Polyzoa is the revision which it contains of *Adeona* and allied genera. A critical comparison of the species of *Adeona* with species belonging to other genera which had been hitherto placed among the *Escharidæ* has necessitated the founding of a new family, *Adeoneæ*, in order to include the whole in a single natural group. This family has several peculiarities, among which the most interesting is the possession by all the species of three different kinds of cells, which the author terms zoœcial, oœcial, and avicularian. Oœcia of the ordinary type are entirely absent, and their function appears to be performed by special cells which differ in form from the others. When decalcified these oœcial cells appear as thick-walled sacs, containing in most cases an ovoid mass, which resembles the contents of an ordinary oœcium, and like these is almost certainly embryonal. Mr. Busk has further made the important observation that in some of them there is lodged instead of this mass a polypide similar to those inhabiting the zoœcial cells, and he concludes that the embryonal mass is derived from a polypide, which it finally replaces.

Among other peculiarities of the Adeoneæ is one which, notwithstanding its apparent triviality, derives importance from its constancy. This consists in the universal presence of a projecting point at each end of the base in the avicularian mandibles both large and small. In doubtful fragments this character alone will often indicate the affinities of the species.

The descriptions of the new species are throughout the work drawn up with that care and precision which characterise all Mr. Busk's zoological writings, while the absence of redundant description and the exclusion of characters not necessary for the diagnosis, give to his definitions a conciseness which will be appreciated as it deserves by all who require to consult the Report.

In a large proportion of the diagnoses the author has had recourse to the chitinous elements of the skeleton. These are the so-termed opercula or oral valves, and the chitinous parts of the avicularia and vibracula; and a very large number of accurately-executed outlines are given in order to show the various forms assumed by these elements in the different species. The employment of the chitinous elements in the classification and descriptive zoology of the Polyzoa is due entirely to Mr. Busk, who has convinced himself that "their value for these purposes cannot be over-rated, while their importance extends far beyond the mere distinction of genera and species."

The descriptions of the species are of course necessarily confined to the hard parts, whether calcareous or chitinous, for, except in living examples, it is rarely possible to determine any facts of importance regarding the soft parts of the colony. The author, however, gives two highly instructive figures of the avicularia of *Bicellaria pectogemma*, in which the muscular apparatus and other soft parts of these curious and still enigmatical bodies are clearly and beautifully represented. In one of his figures of *Carbasea moseleyi* also—a form in which the calcareous walls are quite transparent—there is a very interesting view of the polypides in the interior of their cells.

The distribution of the species, geographical and bathymetrical, finds a prominent place in the Report. An instructive map is appended in which the oceans traversed by the *Challenger* are divided into seven regions, three being to the north and four to the south of the equator, each including 90° of longitude. In each of these regions the stations from which any species of Polyzoa were obtained are indicated.

The bathymetrical range varies within wide limits. The greatest depth which yielded any species to the dredge was 3125 fathoms, in the North Pacific region. From this vast depth four species were procured, and between it and quite shallow water a great number of stations of very various depths are recorded.

One of the most unexpected facts brought out in the Report is the very wide bathymetrical range enjoyed by certain species. Thus *Cribrilina monoceras* is one of the four species brought up from 3125 fathoms in the North Pacific, while the same species was obtained from 1325 fathoms in the South Pacific, from 69 fathoms in the South Indian or Kerguelen region, from 55 fathoms in the South Atlantic, and from 35 fathoms in the Australian region.

This striking difference in the depths inhabited by one and the same species is, however, exceptional; and so is the wide range of geographical distribution which is here presented by a species occurring at great depths. The study of the bathymetrical distribution of the *Challenger* Polyzoa shows that "the extent of geographical distribution is to a considerable degree correlative with the bathymetrical, the wider geographical distribution being in most instances coincident with the shallower depths."

To this law another striking exception is afforded by the beautiful genus *Catenicella*, a genus very rich in species, which, though from comparatively shallow water, are almost exclusively confined to the Australian region.

The thirty-six beautiful plates which illustrate the Report are all that could be desired. Clearly and faithfully drawn, they place in the hands of the zoologist facilities for the determination of the species which, with the descriptions in the letterpress, leave no excuse for erroneous diagnosis.

Though the Report is confined to the species obtained during the expedition of the *Challenger*, the number of these is so large, and the descriptions and figures so exact, that the work will possess a classical value, and be found indispensable by every student of the Polyzoa.

G. J. A.

OUR BOOK SHELF

On the Healthy Manufacture of Bread. A Memoir on the System of Dr. Dauglish. By Benjamin Ward Richardson, M.D., F.R.S. (London: Baillière, Tyndall, and Cox, 1884.)

THIS pamphlet is another of Dr. Richardson's labours in the cause of public health. It deals mainly, as the title implies, with healthy bread, and especially with the system of the late Dr. Dauglish of Malvern for baking what is now generally known as aërated bread. The advantages of the aërated process are stated by the author to be that the destructive influence of fermentation is prevented. There is no chemical decomposition of the flour whatever, and therefore no loss of material, while the rising of the dough is just as effectively carried out. The aërated bread contains, therefore, all the gluten and all the albuminous food of the wheat, out of which the living tissues are constructed, as well as the food which ministers to the animal warmth and vital activity. Moreover, much labour to the baker is spared, and the kneading by hand is wholly dispensed with—a matter of some consideration to delicate or fastidious persons. The gradual steps by which the process has been worked out, from the incubation of the idea in the brain of Dr. Dauglish to the modern aërated process of baking are fully traced by Dr. Richardson, who describes also the different effects of fermentation and aëration on the different qualities of flour, the economic and sanitary advantages of the new system to the workmen (by no means the least important part of the subject, as those who recollect Mr. Lakeman's report on the London bakeries, and who read Chapter IX. of this little work, will acknowledge), and the public advantages of the aërated bread in relation to health. An appendix contains a brief memoir of Dr. Dauglish.

Proceedings of the Edinburgh Mathematical Society. Second Session, 1883-84.

OUR readers have seen from time to time in our "Society" Notices the titles of papers read before this young but from the outset vigorous body, and must have often wished for a more intimate acquaintance with their contents (as the odoriferous steam issuing from the cookshop tempts the hungry "Arab" to enter and feed). We are glad to find, from the volume before us, that the Society is in a position to print its *Proceedings*, for we now know how interesting the papers are. They are not, like some other papers nearer home, caviare to the general, but they deal with matters which come home to every mathematical teacher. Mr. Mackay writes on the circles associated with the triangle, viewed from their centres of similitude; Mr. Muir, on the condensation of a special continuant; Dr. Macfarlane, on voting; Prof. Chrystal, on an application of matrices to spherical geometry, on a problem in partition of numbers, &c. Mr. Allardice furnishes some useful notes on spherical geometry and trigonometry; Mr. Browning, some illustrations of harmonic section; Mr. Barclay, notes on the teaching of elementary geometry (abstract only), and Mr. Traill, proofs of the theorems as far as "Euclid" i. 32, from first principles. Other papers are: a good concise account of Pascal's "Essais pour les Coniques" by Mr. Macdonald; the hypothesis of Le Bel and Van't Hoff, by Prof. Crum Brown; on the representation of the physical properties of substances by means of surfaces, by Mr. Peddie; and a joint account of the problem "La Tour d'Hanoi" (one of displacements), by Messrs. Allardice and Fraser. With these *Proceedings* are bound up Prof. Tait's introductory address on Listing's "Topologie," which, our readers will remember, has been published in the *Philosophical Magazine* (January 1884, pp. 30-46, with plates), and Mr. Muir's Presidential Address entitled "The Promotion of Research; with Special Reference to the Present State of the Scottish Universities and Secondary Schools" (delivered February 8, 1884).

Elementary Text-Book of Trigonometry. By R. H. Pinkerton, B.A. (London: Blackie and Son, 1884.)

THIS elementary text-book of 176 pages contains all the essentials for obtaining a knowledge of trigonometry proper. It might be used either by those who desire merely a thorough grounding in the elements, or, as a first book, by those who intend to take a full analytical course. The arrangement is good, the text well written, and the examples, worked and unworked, are numerous and judiciously chosen. The introductory chapter on the measurement of angles is particularly commendable. We should prefer, however, not to write "$\pi/3$ radians" but "$\pi/3$ radian," reading it "*pi*-thirds of a radian." It may be suggested also to a writer who has the courage to introduce reforms, whether the time has not come for dispensing with the so-called *tablogsines*, *tablogcosines*, &c., and using only logsines, logcosines, &c. *Tabular* log functions are, according to our experience, well-meant aids which only hinder.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Iridescent Clouds

ON Thursday evening, December 11, about fifteen minutes after sunset, in the south-west direction as seen from the Royal Observatory here, were two rather large clouds about 10° or 12° high, and below them several much smaller ones, all of them of the most brilliantly iridescent colours and nothing but bright colour, of a kind I do not remember to have seen before, though they were not improbably like some described by several of NATURE's correspondents last year.

The principal cloud, some 5° or 6° long and 2° or 3° across, exhibited a diagonal band of glowing green, passing through blue into exquisite violet on either side, while it was fringed nearly all round by dull red.

The second largest cloud, a little below and rather to the eastward of the first, exhibited all the same colours in similar diagonal bands, but unconformably with the places of the bands of the first produced down to it; though both may have had their bands at right angles to a ray from the sun long since set, but directed on their centres. The sky behind them and all around was singularly dark and sombre, so that these iridescent clouds, in the brightness and richness of their colouring, reminded one more of mother-of-pearl inlaid in a black tea-tray than any ordinary sunset sky.

The smaller clouds of the same kind lower down gradually lost the central green band and passed into yellow and orange, but were still phenomenally bright specks of luminous material on the dark general background. All this towards the south-west; while west and north-west the sky was nearly clear, and exhibited, in a sunset-illumined sky "proper," a fairly fine but quite ordinary set of thin cirro-stratus rolls of cloud, warmly coloured on one side and cold-gray shaded on the other, like any corporeal body in the same exposure.

Lower down still on the horizon was a heavy cumulo-stratus cloud, which the west wind presently brought up to eclipse the green and blue iridescent clouds, proving that they were higher than it, though not so high as the dark cirrus haze to the south-west that had served so well to set forth their brilliant and unusual colouring. C. PIAZZI-SMYTH

Edinburgh, December 13

A STRIKING phenomena, apparently a new phase of the cloud-glows, was widely witnessed here on the 13th, and I myself noticed it, though on a much less scale, and in the north-

east, on the 11th. About 3.30 p.m. the upper edge of a dark, very lofty haze cloud, stretching almost straight from alt. 15° in the south-south-west, to about alt. 20° in the north-west, was fringed with prismatic colours, in parts thrice repeated, separating the dark haze cloud from a bright white haze, like that often seen of late near the sun, which itself was nearly setting. The luminous haze was widest, about 5°, above the sun, and was also, but far more faintly fringed, with a hazy blue sky above. It lasted until 4.20, but at 4.10 the dull cloud was a deep violet, and the bright haze a steel blue. They both seemed to disappear in the dusk, but the bright glow reappeared about 4.40 p.m.

On both occasions the phenomenon lasted long after sunset, and the cloud was quite distinct from the feathery cirri on which, if near the sun, one so often sees prismatic effects. On the 11th the two small oblong clouds affected had the colours in regular bands, in one round a dark, in the other round a bright centre, reminding one of Newton's rings. J. EDMUND CLARK

York, December 15

The "New" Volcanic Island off Iceland

KNOWING the interest which, from their association with the later years of the Gare-fowl's existence, I have long taken in the islets lying off the south-west point of Iceland, Prof. Lütken has most kindly sent me a copy of the Copenhagen newspaper *Dagbladet* for the 7th of this month, containing an article by Capt. C. Normann of the Danish Royal Navy, in command of the ship *Fylla*, during her recent scientific voyage to Greenland, a distinguished officer and an eminent authority in Arctic matters. The article is long—too long for my powers of translation—but, with the friendly help of a Danish young gentleman of this University, I have mastered it, and find it exceedingly entertaining. It treats of the island which, as already announced in these columns (vol. xxxi. p. 37) and elsewhere, is said to have been lately thrust up, as other islands have before been known to be upthrust (at least temporarily) in that volcanic neighbourhood. According to the statement of Mr. Consul Paterson (*loc. cit.*) it is said to have been first observed by the lighthouse-keeper at Reykjanes on July 29; and it would seem that news of its apparition speedily reached Reykjavik; but unfortunately, says Capt. Normann, there was then no ship there available to make search for it. Rather less than a month later, however, the *Dupleix* and *Romanche*, of the French navy, arrived at that port, and the commander of the former, animated with the laudable desire to determine the position of the new island, and if possible to effect a landing upon it, resolved to do so in the course of his homeward voyage, and, with that intent, set out after a short delay. To the surprise of all at Reykjavik, he, as he subsequently informed the French Consul there, could find no trace of the object of his search on August 24. On the departure of the *Dupleix*, however, the commander of the *Romanche* dispatched two of his officers, equipped with proper instruments, by land to Reykjanes, thence to take the bearings of the new island. On August 26 they undoubtedly saw an island corresponding in position with what they expected to see, and reported accordingly to Reykjavik, where Capt. Normann's *Fylla* had arrived on the 25th, on her homeward voyage. The Danish commander, equally enthusiastic in the cause of scientific discovery, accordingly left Reykjavik early on the morning of the 27th, and soon after mid-day his ship was off Reykjanes, whence he pursued a course along the northern side of the bank from which the Fowlskerries emerge, seeing nothing of the new island, it is true, but that time the weather was thick. However, he passed cautiously (as well became a navigator in water liable to volcanic upthrusts) along the whole range, and even beyond the furthest of the emerged skerries—the Geirfugladrángr or Grenadeerhuen, when it began to grow dark, and also to blow. Next morning he turned back, running still along the northern side of the bank. It was clear and beautiful weather, and the rock just named, as well as Eldey or Melsække, the innermost of the range, stood out in bright sunshine. Breakers marked the position of the old Geirfuglaskér, which sank beneath the waves in 1830, and the neighbouring coast of Iceland, as well as the inland fells, was plainly visible, but nothing in the shape of a "new" island was to be seen. So he came back to about midway between the Meal-sack and Reykjanes—the lead giving a depth of eighty fathoms of water. Thence, thinking that after all there might be some mistake in the reported position of the island, he put his ship's head about, and ran along the southern side of the bank. But again was he disappointed, for no new island met the anxious gaze of all on board.

It remains to be said that a day or two later the *Romanche* came to the same spot, but alas, nothing new was to be found—not even a pumice-stone by which, as Capt. Normann remarks, all decent volcanic islands are expected to indicate their position, even when submerged. Still, the form of the "new" island went on gratifying the vision of the lighthouse-keeper at Reykjanes; and, as Mr. Paterson has told us (*loc. cit*) it was seen by him through a telescope on September 9. I do not for a moment doubt that both he and previously the officers of the *Romanche* saw what was pointed out to them as the "new" island; but, from all that has been said before, and from my own knowledge of the locality, gained during a two months' stay at Kykjuvogr and the neighbourhood in 1858, neither do I doubt that Capt. Normann is perfectly right in asserting that the supposed "new" island is a very old friend of mine—the Geirfugladrángr or Grenadeerhuen before mentioned—the outermost of the emerged Fowlskerries, and our best thanks should be given to that gallant and scientific officer for dispelling the mystery. ALFRED NEWTON

December 14

Overpressure in Schools

I HAVE carefully read Dr. Gladstone's article on over-pressure. Over-pressure is due more to the action of inspectors and teachers than to the requirements of the Code; *e.g.* a teacher in my district has a first class in an infant school, the children being all about six years of age. Owing to the unusual brightness of the children and their regular attendance, the teacher has had no difficulty in training her class in the three R's for first standard work, which, under ordinary circumstances, they could not do until they were a year older and in a higher class. What is the result? An inspector visits that school, finds the children can do much more than is required by the Code, and, without reflecting *how* this has been accomplished, he gives a good report for that class. The following week he visits another school in the same neighbourhood and examines a similar class; these children, he finds, are not so far advanced as those examined the previous week, and therefore he makes a less favourable report, thinking that the teaching-powers are not so good, although the children have really been quite as well taught, and are fully up to the requirements of the Code. When the report comes to the latter school, the teacher cannot understand how it is that the class has not gained the report it deserved, until by and by she hears indirectly what has been accomplished at the school previously examined. Then she says, "If they can do it at that school, we can do it here." Hence *over-pressure.* If inspectors did not examine beyond the Code, teachers would not train children for a higher standard than the Code requires.

Dr. Gladstone says, "Teachers used to be paid partly from the Government grant, and thus had a pecuniary incentive to press forward the feeble so as to insure a pass." That is quite true, but teachers will be found in the future to be quite as anxious as they were in the past as to the results of the examinations. They know quite well that now the salaries are fixed, and do not depend on results, it would be said directly that they did not take the same interest in their work as formerly if perchance the schools passed a less favourable examination, and on this point they are keenly sensitive.

Dr. Gladstone advocates "varied and appropriate occupations in infant schools." It is no doubt very monotonous for little children to be kept closely to the study of the three R's, but there are very few who really like the Kinder Garten as taught in our infant schools, unless it be the Kinder Garten games: it is *not* play, but hard work for such little ones to do. It is impossible for the work to be taught successfully when a teacher has too large a class under her control; in Belgium an assistant mistress has a class of fifty children with a pupil teacher to help her, and then no doubt Kinder Garten can really be carried out with beneficial results to the children, but in the London Board schools, where an assistant teacher has seventy or eighty or even more in her class *without help*, how is it possible to obtain good results? If Kinder Garten is to be taught with success there ought to be a Kinder Garten mistress appointed by the Board to teach it to the children, and I think there are very few teachers who would not agree in this. Of course it would entail extra expense, but it would be an expense more beneficial to the

children than some that are indulged in. These I believe to be the views of nearly all teachers as well as those of myself, who am but a SCHOOL TEACHER

December 8

The Tokio Earthquake of October 15, 1884

AT 4h. 21m. 54s. a.m. the inhabitants of Tokio were awakened by a sudden and violent earthquake. In Yokohama, which lies about sixteen miles south-west by south from Tokio, the disturbance was noted at 4h. 21m. 38s., that is to say, sixteen seconds before it was felt in Tokio. The chief source of error in these time-records—if error exists—will probably be due to observers at different stations having noted time at different portions of the disturbance, the length of which, as determined by the sensations of those who made the records, was about one minute, but, as recorded by a seismograph, between five and six minutes. At the commencement of the disturbance four complete waves were described in three seconds, but at the end of the disturbance the motion became so slow that each wave occupied from two to three seconds. From a record taken by Mr. K. Sekiya, a gentleman whose especial duty it is to attend to the earthquake phenomena of this country, it would appear that the maximum range of motion may have reached 42 mm. The maximum acceleration per second per second was about 500 mm., that is to say, the intensity of the earthquake or its destructive power was similar to that which would be experienced by a building standing on a carriage which was suddenly caused to move with a velocity of about one foot and a half per second, or if, such a carriage having gradually acquired such a velocity, it had been suddenly arrested. The result of the earthquake was to overturn a few chimneys in Yokohama and to crack one or two in Tokio.

Our last severe earthquake was on February 22, 1880. On that occasion in Yokohama very many buildings lost their chimneys and were unroofed, whilst in Tokio the damage was chiefly confined to loosening tiles and shaking down plaster. Had our buildings in Japan been constructed like those in England, it is probable that this last shake would have caused about the same amount of damage as that which was so recently caused by the late disturbance in Essex. From the observations on direction, coupled with what has been said about time, it seems that the earthquake had its origin in Yedo Bay, at or about the same point as that which was determined for its severe predecessor.

It may here be remarked that nearly all the heavier earthquakes which are felt in Tokio and Yokohama practically have had a common centrum. They are not large earthquakes as measured by the area shaken, but they are severe because we are near to their origin.

The earthquake of 1880, according to a record furnished by one of Palmieri's instruments, had an intensity of 78°, whilst the recent earthquake, the actual intensity of which, as deduced by its destructive effect, was much less, is given as 95°.

These intensities measured in degrees really indicate the height to which a certain quantity of mercury in a bent tube was caused to wash—the height of the "wash" being measured by the turning of a pulley connected by a string to a small weight floating on the surface of the mercury. It would seem evident that the magnitude of the records obtained in this manner must among other things depend upon the duration of the earthquake, the period of its waves, and the depth of the mercury contained in the tube. For reasons such as these, records like those just given cannot be regarded as anything more than roughly approximative.

In connection with the remarks made on the amplitude it may be stated that the seismograph by which the record was taken was situated on soft soil in the flat portion of Tokio. This amplitude, had it been recorded on the hard ground of a hill, probably would not have exceeded 25 mm.

One of the most remarkable points connected with this disturbance were the changes in level as observed by the displacement of specially arranged pendulums, which took place before the shock, and again about six hours afterwards.

J. MILNE

Large Meteor

ONE of the largest meteors that I have seen for some years appeared at 7h. 15m. 15s. this evening. It began as a speck, north of Vega, at about 4° greater altitude than that star. The course was perpendicularly down, only disappearing by passing below the horizon. It was 2° east of Vega on descending to the altitude of that star, and by that time had increased to fully a quarter the apparent size of the moon, and this size it maintained whilst above the horizon. The colour was an intense blue, and there was left a streak of orange-red elongated separate stars in its track, and this streak was about 1° in length, although the separate stars of which it consisted disappeared almost as rapidly as they were formed. The stars, like the meteor, increased in size and brilliancy from a mere point, and instantly vanished on attaining their maximum brightness. Each moved perpendicularly down for the length of about half a degree, and left a continuous momentary streak. None of these stars were seen within half a degree of the meteor, and their ignition was confined to the centre of the meteor's path. Their size was tolerably equal, being about that of a second-magnitude star. The speed of the meteor was unusually slow, it being visible for nearly six seconds. The shape was circular in front and cuneate behind (bluntly conical). Its brilliancy was great, considering the presence of a nearly full moon.

Shirenewton Hall, near Chepstow, E. J. LOWE

December 4

The Cost of Anthropometric Measurements

ALLOW me to correct an absurd typographical blunder in the account of my anthropometric laboratory at the Healtheries, which appears in Mr. Ernest Hart's lecture at the Society of Arts. It originally occurred in the *Journal* of the Society of Arts, whence it was copied into your columns (p. 142) last week. The effect of the error to which I refer is to make the statement that the cost of measuring each person at the laboratory in seventeen different ways was *3l.*, whereas it should have been *3d.* The subsequent argument, based on the extreme cheapness of the process, becomes in consequence unintelligible. I write myself to make the correction, because the part of Mr. Ernest Hart's address which refers to the anthropometric laboratory was written for him, at his request, by myself. I regret I had not an opportunity of revising it in proof.

FRANCIS GALTON

The Northernmost Extremity of Europe

As "a Norwegian" now fully admits that the pretended discovery of Capt. Störensen is no discovery at all, but an elementary fact well known and long known to Norwegian geographers, I need not discuss that question any further, but I must protest against his reference to Sönsberg's "Norge," which is the joint production of some of the most eminent men in Norway. Sönsberg is the *editor* and *publisher*.

Amongst the writers who have co-operated to produce the national "Handbook" are the following:—Lieut.-Col. Broch, Chief of the Geographical Survey of Norway (he is the largest contributor, and the writer of the words I quoted), Prof. H. Mohn, Prof. T. Kjerulf, Prof. Rasch, Prof. L. K. Daa, Sorenskriver, H. Thoresen, J. B. Halvorsen (the well-known writer), Beaureauchef Kjer, and Secretary Mohn, Th. Bœck (Royal plenipotentiary), J. N. Prahm, Capt. Scharfenberg, E. Mohn, Lieut. Flood, Capt. Overgaard (the Inspector of Forests), Hörbye, Lieut. Langeberg, and Mr. Langeberg, K. Lassen, Dr. Kahrs, Lieut. Solem, O. T. Olsen, Capt. Bang, Capt. Haffner, and Sorenskriver Nannestad.

All these names are given in the preface, and the contributors of each carefully specified. This was known to "A Norwegian" when he wrote his last letter, for he refers to that same preface, and yet asserts that Sönsberg "never claimed the least *geographical* authority for a faulty and crude guide to tourists" (his own italics). That preface is written for the express purpose of claiming such authority and thanking the authors. It makes special claim in a special paragraph of the *geographical* authority of the "head of the Geographical Survey," Lieut.-Col. Broch, whose name, Sönsberg says, "offers a sufficient guarantee of correctness."

The anonymous "Norwegian," in further disparagement of the book, states that in this preface "the author himself says that for reasons explained it has many faults." I will quote this very damaging confession. It is as follows:—"A few errors and misprints will be found here and there." A list of them is given. After this the flippant misrepresentation of my pretensions in the last paragraph of the letter is not surprising, and demands no further notice.

I make this protest, knowing that NATURE is largely read by

well-educated Norwegians (who all read English as a matter of course). They cannot fail to be indignant if such unjust treatment of a national work, which genuine Norwegians understand and appreciate, is allowed to pass unrefuted. Besides which, Englishmen in search of available and reliable information concerning Norway might be grossly misled.

W. MATTIEU WILLIAMS

APOSPORY IN FERNS

A PARAGRAPH in the report in NATURE (p. 119) of the meeting of the Linnean Society for November 20 last contained what is, to the best of my belief, the first publication of one of the most interesting botanical observations which has been made for some time. As it is quite possible that this brief record may escape the notice of a good many botanists, I venture to give the matter a little more prominence.

At the meeting referred to, Mr. E. T. Druery made a second communication (the first did not, I think, receive any record) upon a singular mode of reproduction in *Athyrium Filix-fœmina*, var. *clarissima*. In this fern the sporangia do not follow their ordinary course of development, but, assuming a more vegetative character, develop more or less well-defined prothallia, which, according to Mr. Druery's observations, ultimately bear archegonia and antheridia. From these adventitious prothallia the production of seedling ferns of a new generation has been observed to take place in a perfectly normal way.

Mr. Druery very kindly offered at the meeting to supply me with some of his material. This reached me on November 29, and I immediately placed it in the hands of my friend Mr. F. O. Bower, who was engaged in other research connected with the vascular cryptogams in the Jodrell Laboratory of the Royal Gardens. Although in the material sent me the abnormal development of the sporangia had not proceeded very far, Mr. Bower obtained evidence which, as far as it went, was entirely confirmatory of the correctness of Mr. Druery's observations. With appropriate cultural treatment prothalliform bodies have already made their appearance, but have not yet reached the stage at which archegonia and antheridia are developed. They are, however, furnished with root-hairs.

This is, however, not all. Mr. Bower placed himself in communication with Mr. Druery, and paid a visit to his collection of ferns. By the kindness of this gentleman he was allowed to bring away specimens of another fern (*Polystichum angulare*, var. *pulcherrima*) which altogether eclipses the *Athyrium*, remarkable as that is. In the *Polystichum* the apex of the pinnules grows out into an irregular prothallium, upon which Mr. Bower with little difficulty was able to demonstrate at Kew the existence of characteristic archegonia and antheridia. In this case the production of the prothallium is not even associated locally with the sporangia, but it appears as a direct vegetative outgrowth of the normal spore-bearing plant. The oophore is a mere vegetative process of the sporophore, a suppression of the alternation of the two generations which exceeds even that which obtains in the flowering plant.

Mr. Druery's discovery, for which I have borrowed Mr. Bower's convenient term Apospory, is the direct converse of the Apogamy in the fern, discovered by Prof. Farlow. In this the sporophore is a vegetative outgrowth from the oophore. The parallel phenomena in the life-history of the moss have been known for some time. But this point and all detailed observations at present available will be dealt with in the communication which Mr. Bower will make at the meeting of the Linnean Society this (Thursday) evening. While every merit must be attributed to Mr. Druery for the first observations of this important fact, he has with great liberality allowed Mr. Bower free liberty to discuss the histological and theoretical points involved.

The obvious possibilities of discovery with regard to the reproduction of ferns may now be regarded as exhausted. It may be interesting to give the dates of the different steps:—

1597	Gerarde	Observed seedling plants near parents.
1648	Cæsius	Sporangia.
1669	Cole	Spores.
1686	Ray	Hygroscopic movements of sporangia.
1715	Morison	Raised seedlings from spores.
1788	Ehrhart	Prothallium.
1789	Lindsay ...	Germination of spores.
1827	Kaulfuss	Development of prothallium.
1844	Nägeli	Antheridia.
1846	Suminski	Archegonia.
1874	Farlow	Apogamy.
1884	Druery	Apospory.

Royal Gardens, Kew W. T. THISELTON DYER

MODERN ENGLISH MATHEMATICS[1]

YOU will remember that two years ago it was announced from this chair that the Council had settled the conditions under which the De Morgan Medal should be given, and that the first award would be made at the anniversary meeting of 1884.

I have now to make the announcement that the Council has decided that the first medal should be given to Prof. Cayley, in acknowledgment of his work in the theory of invariants.

As this is the first award of the medal, I may remind you of its origin. Soon after the death of De Morgan, some of his admirers started a subscription for the double purpose of having a bust executed and founding a medal to be given in his memory. The *bust* now adorns the library of the London University, where also his valuable collection of books is preserved. The *medal* was offered to the Mathematical Society, and its Council accepted the honourable duty of determining its award. There is a peculiar fitness in the medal being thus connected with our Society; for this Society was founded with the active co-operation of De Morgan by a number of his advanced students, among whom his talented son George, who died soon afterwards, took the lead. De Morgan himself was the first President, and our *Proceedings* begin with a very characteristic opening speech by him.

The medal is to be given for eminent original work in mathematics, and no more fitting memorial than this could in my opinion be devised for a man who spent his whole life in carefully preparing the foundation for such work by his teaching and his writings.

De Morgan was pre-eminently a teacher. His most original work does not so much increase our stock of mathematical knowledge, but is concerned with mathematical reasoning, and with exact reasoning in general.

In the opening speech referred to, De Morgan himself divides exact science into two branches, *the analysis of the necessary laws of thought*, and *the analysis of the necessary matter of thought*. His own work belongs to the former. He was a logician much more than a mathematician in the ordinary sense of the word, and when reading his mathematical works I have always had the feeling that he studied mathematics not so much for its own sake as on account of the logic contained and exemplified in it. I once made this remark in the Professors' Common Room of University College, when an old colleague of his turned round and said, "You are quite right, he told me so himself."

In this work De Morgan did not stand alone. We may almost take him as a type of his period. It has often struck me as a noteworthy fact that in England, after the long pause in mathematical activity, the work taken first in hand was investigation into the very bases

[1] An address delivered by Prof. Henrici, F.R.S., at the annual meeting of the London Mathematical Society (November 13), on the occasion of presenting the De Morgan Memorial Medal to Prof. Cayley, F.R.S.

of mathematics and more particularly into mathematical reasoning. These investigations became partly a mathematical analysis of logic itself and partly a logical analysis of the laws followed by the symbols and operations used in mathematics. De Morgan worked in both directions; we have his "Formal Logic" and his "Double Algebra." Operations were studied quite independently of the meaning given to the symbols. Originally the symbols stood for concrete things, and each operation had its concrete meaning. At present symbols are sometimes used without giving them any meaning whatsoever, and without defining them at all, and then the operations for combining these symbols are arbitrarily defined, with the sole restriction that they do not contradict each other.

Each new set of operations thus establishes a calculus. If afterwards any entities can be found which can be combined by operations answering the characteristics of the operations used in the new calculus, then the latter may be employed for a theory of those entities, and its results will allow of an interpretation. These entities themselves may be anything, concrete things, or logical concepts, or ordinary algebraical quantities.

Thus the ground was already prepared for greatly extending the realm of algebra and the scope and power of algebraical operations, when the genius of Prof. Cayley conceived the idea of invariants [1] which has given rise to that marvellous growth of our science which has suddenly brought England again far to the front.

It was known from Gauss's investigations that for quadratic expressions a certain combination of its constants, its determinant, exists, which has the following property.

If the quadratic expression be transformed into another by a linear substitution, then the determinant of the transformed expression is obtained from that of the original expression by multiplying it by a factor which depends solely on the substitution used.

Afterwards Eisenstein discovered that a similar theorem holds for a cubic expression of one variable. These isolated facts suggested to Cayley that combinations of constants having this property must exist for all algebraical expressions. The problem was how to find these.

The manner in which this has been solved I need not restate here, but I wish to call your attention to the fact that the symbolic methods worked out by the school of mathematicians referred to have been of the greatest use in the development of the theory of invariants, which could scarcely have been brought to its present perfection without it.

It would be an impertinence for me to say much either in praise of Prof. Cayley's work or in justification of the Council's choice. Prof. Cayley has invented and worked out the theory of invariants, and in steady life-long work connected it with nearly every branch of mathematics, enriching everything he touches, and everywhere throwing open new vistas of future work.

The Council of the Mathematical Society in selecting Prof. Cayley as the first recipient of the De Morgan Medal, and thus doing homage to his genius, did so not so much with the idea that it could add honour to his name as that they might add honour to the medal by connecting his great name with it, and thus increase its value for all future recipients. And it is befitting that a body like the London Mathematical Society should give formal expression to the reverence and admiration in which it holds the greatest among its members.

[1] Prof. Cayley, when returning thanks, distinctly waived the claim of priority in favour of the late Prof. Boole. See also Salmon's "Higher Algebra," p. 294.

PHYSICAL GEOGRAPHY OF THE MALAYAN PENINSULA

AS some remarks of mine on the mountain system of the Malayan peninsula have already appeared in NATURE, perhaps the following summary of the results of ten months' explorations in the State of Perak will be interesting.

The State of Perak is comprised between the sea (Straits of Malacca) and the main central chain which runs along the centre of the peninsula. Its boundaries are, roughly: north, the River Krian; south, River Bernam; west, the ocean; east, the main central chain. The geology may be briefly described as consisting of—

(1) An immense granite formation, rising into extremely sharp and precipitous parallel ridges having nearly a meridional direction. This granite passes frequently into slates and schists. The prevailing colour is blue.

(2) A Palæozoic formation of slates, mottled sandstones, and clays, forming outliers or detached portions. It is found most abundantly at the foot of the ranges, whence it usually dips away conformably to the slopes of the hills and mountains. It has evidently been subject to great denudation.

(3) Limestone in detached outliers, or isolated hills of precipitous character, showing much denudation. It is stratified or crystalline. No fossils have been found yet, but is probably of Palæozoic age. From its wide extension throughout Perak, where it crops out in so many places, it may have once covered the whole of the granite and Palæozoic clays.

(4) Drifts and alluvium from the ancient streams and river beds. These are formed of the material from all the preceding deposits. All the tin deposits of the country are in these drifts. The ore occurs in a manner very similar to the alluvial gold in Australia, that is to say, in "leads," which are the ancient or modern river beds.

Above these alluvial deposits there is the usual alluvial surface soil, for the most part supporting a very dense vegetation.

The tin deposits hitherto found are all stream tin. No lodes have yet been worked, though there are some in the mountains round the sources of the Perak River. The ore is almost always cassiterite in small abraded crystals. It is of a peculiar blackish-gray or brown aspect. Any person with a little experience would be able to distinguish between tin sand from Australia and that of Perak. The former is rather rich in gems, such as sapphires, rubies, hyacinths, garnets, topazes, and zircons. I have never seen any in Perak; but there is a good deal of fluor-spar, tourmaline, and less frequently wolfram.

The most of the workings are on the western slopes at the foot of the mountains. I cannot recall any instances of mines on the eastern slopes, but the wash or drift seems to have been greater on that side.

The matrix of the tin seems to be in the upper part of the granite at its junction with the Palæozoic clays. In the lower part of the clay there is also a small quantity of tin.

In the drift the tin is always found in nearly the lowest levels, lying in one or two strata from one foot to five feet thick. It is mingled with fine drift sand and gravel. Its position is, I think, due to the repeated sifting and washing it has been subject to in the stream bed. But as it is generally covered by from ten to thirty feet of material destitute of tin, the inference is that only one part of the granite was very rich in the metal.

The stream tin deposits lie upon (1) kaolin clay, or partly decomposed granite; (2) granite; (3) Palæozoic sandstones and clays. In the latter case the stream has come from the denudation of a portion of the same strata on the upper slopes of the hills.

On the highest granite ridges, or those above 5000 feet, there is found a distinct vegetation. Three or four of the genera are Australian (*Melaleuca*, *Leptospermum*, *Podocarpus*, *Leucopogon*), and two of the species (*Leptospermum* and *Leucopogon*) are common Australian forms. Similar facts have been observed in Borneo, but I have

not heard that they had been observed in the Malay peninsula. Nothing of the kind is seen on the lower slopes of these mountains even 100 feet below the summit. This Australian flora may be the relics of an ancient flora, which once included the Eastern Archipelago. But it does not appear why the species should be confined to the tops of the mountains. They grow in a much warmer climate in Australia.

There are no table-lands in Perak; the mountains are all sharp ridges. There is not the slightest sign of any recent upheaval of the coast-line, while the evidence of subsidence is equally absent. But the land is rapidly encroaching on the sea owing to the immense alluvial wash brought daily from the mountains in this land of heavy rains. Thus the shores are fringed with large mangrove swamps which yearly extend, and the Straits of Malacca form a shallow sea full of mud banks and shoals. The seas are consequently rather poor in certain forms of marine life to which muddy sediment is unfavourable.

Though the tin has been worked for centuries, only a comparatively small portion of the country has been worked out or worked at all. I consider that the deposits in Perak are practically inexhaustible. The mining industry is almost exclusively in the hands of the Chinese, who are almost the perfection of colonists for a country like this. Malays are not good miners. Gold is found associated with tin, but small, scaly, in sparing quantity, and only in one or two places.

There are only two instances known to me of the occurrence of recent volcanic rocks: one is in the Kinta River valley, the other on the western face of a small group of mountains not far to the east-south-east of the island of Penang, and near the Karau River. The rocks appear to be basaltic dykes, but the thick jungle and surface weathering prevented a proper examination.

The mountain system of this native State consists of detached groups of mountains which cover the west side of this part of the peninsula, an almost continuous range close to the sea in the Straits of Malacca. These groups of mountains form parallel chains about thirty miles long, with a direction a little oblique to the true meridional line. Sometimes they are wholly detached groups, so as to allow rivers from the eastward to pass between them. Such an instance is seen in the ranges between the Kinta and Perak rivers. This group terminates to the north so as to allow the River Plus to pass to the westward and to the south so as to give an outlet to the Kinta. Both rivers join the Perak River, which flows round another group (Gunong Bubu), and then flows into the sea in the Straits of Malacca.

The islands of the coast, such as the Dindings and those off the State of Keddah (Pulo Leddas, Pulo Lankawi, and Pulo Buton, known as the Buntings), are probably portions of similar groups, and so are Pulo Penang and the attendant islands. These groups and those on the mainland usually run in sharp parallel ridges, variously modified by oblique spurs, which at times connect the main chains forming watersheds which throw off small streams north-east and south-west.

The following are the principal groups of mountains known to me, beginning at the south:—

Dindings Islands.—Off the coast in front of the Dindings River (*Dinding*, Malay for boundary or partition), lat. 4° 12′ N., there is a series of islands of moderate elevation not exceeding 1000 feet in their highest peaks. They are granite, rich in tin, with a little fine scaly gold. They are densely clothed with jungle, and have fringing reefs of coral. I have visited three or four of these islands, and they are all of the same character.

On the mainland there is a cluster of hills called the False Dindings, from the fact that at a short distance they look like islands. These are also granitic, and tin occurs in the alluvial beds derived from them. They give rise to small rivers, such as the Dindings and its tributaries.

Gunong Bubu.—North-east of this group, but quite detached from it, is a series of parallel mountain ridges with a uniform trend of north-north-east. These ridges are eight or nine in number. The central one is the highest, culminating in Mount Bubu, a fine peak of about 5600 feet elevation. All the ridges are granitic, with occasional patches of metamorphic schists, all more or less rich in tin. A remarkable character in this range is that all the ridges are extremely steep, and frequently interrupted by granite precipices of 1000 feet and more. Gunong Bubu is only accessible in one or two places, the summit being surrounded by escarpments of rock of great height.

Many small streams join the Perak River and the sea from this range. The Kaugsa and Kenas both flow into the Perak to the eastward. In an ascent made by me to the summit of Mount Bubu I was able to explore some of the sources of both these rivers, which afford a home to many a rhinoceros, but few other animals except monkeys (*Hylobates*, *Semnopithecus*, and *Macacus*). The rivers descend many hundred feet in a series of cascades, giving rise to some of the finest scenery in the Malay peninsula.

North of Mount Bubu this group of ridges falls away abruptly, leaving a narrow pass (Gapis Pass) between them and the next group. This pass is about 400 feet above the level of the sea, and therefore too elevated to permit of any river outlet.

Mount Poudok.—In Gapis Pass, or rather at the eastern end of it, there is an isolated hill of highly crystalline limestone. It is an outlier of the great Palæozoic limestone formation already referred to. It is about 400 feet high, and quite precipitous. Its junction with the granite or Palæozoic clays is not visible. Its bright blue and red precipices crowned with dark-green jungle make it a singular and beautiful object, but there are many similar in the State.

Mount Ijau.—North of Gapis another group of ranges succeeds, culminating in Mount Ijau (Malay for green) at about 4400 feet above the sea. This cluster of ridges appears to me to be of nearly the same dimensions as the Mount Bubu group, but not so high by 1000 feet or so. I estimate that each group is from twenty to twenty-five miles long, and fourteen to sixteen broad, covering an area of about 400 square miles. This, however, is only a rough estimate formed from views I have been able to obtain from the summits of other mountains. I have not been able to examine personally the termination of the Mount Ijau group on the north. From the sea one is able to perceive a distinct pass like that of Gapis. It is probably about the same height, and does not form the outlet of any river from the eastern side.

Kurau Group.—North of Gunong Ijau is another group, which I do not know how to distinguish except that it forms the watershed of the Kurau River. Its highest point is a mountain which is also called Ijau by the Malays. I have not ascended the peak, but it seemed to me less elevated than Mount Ijau to the south.

Mount Inas.—What the Malays of Keddah call Mount Inas is the highest point of another detached group north of the Krian and Selama Rivers. I have been within a few miles of the foot of this mountain, and it seemed to me to be somewhat over 4000 feet high, and the highest point of an isolated group of ridges.

Keddah Peak.—North of Mount Inas, in the State of Keddah, there is, close to the sea, a detached group of mountains, at the foot of which the Keddah River flows. Keddah Peak is the highest summit,—probably over 4000 feet high. This is in what is called Lower Siam, in which I have only travelled to a very trifling extent north of the Krian River, the boundary of Perak State. In the north of Perak, near Patani, we have other groups of mountains. An Italian explorer named Bozzolo, who

has lived many years in Siam, assures me that he has travelled round the Gunong Kendrong group at the head of the Perak, and that it is quite detached from any other hills.

Perak River.—The whole of these groups are sufficiently connected to prevent any drainage from the central range flowing directly to the west coast of the peninsula. Thus the Perak River, which has its sources in the Keddah and Patani Mountains flows to the southward for over 180 miles. In its course it is joined by two important rivers from the eastward, namely, the Plus and Kinta.

Plus River.—The Plus River has its sources in the high mountain groups east of Mount Inas, and in the main range. It flows round the southern end of a group called by some the Bukit Panjang Range, and then joins the Perak.

Kinta Ranges.—South of this junction is a group of mountains called by some the Kinta Ranges. This group is about twenty-five miles long. It is perfectly detached from all the others, having a generally north and south direction, but sending off spurs from its west side a little to the west of south. The group is entirely granitic, but on its lower slopes has thick deposits of limestone belonging to the formation already referred to, above and below which tin is worked. For about twenty-five miles this range separates the valley of the Perak River from that of the Kinta, which flows on its eastern side. The highest peaks rise to about 3750 feet above the sea, and give rise to small streams which all flow into the Perak. There is a remarkable uniformity in three or four of the highest summits, which are about the centre of the chain, Mounts Merah (red), Prungin, &c. They are all within a few feet of the same height. From these mountains the range falls away gradually to the south, and sends off two considerable spurs to the south-west. Where it ceases the River Kinta joins the Perak.

Kinta Valley.—The valley of the Kinta River is about as wide as that of the Perak. The river flows, like the Perak, on the eastern side of the valley. The eastern tributaries are many and important. On the sides limestone granite and schistose slates crop out. To the eastward there are many detached hills of limestone fronting the main central chain. They form very characteristic features in the landscape, from their precipitous outline, and the brilliantly coloured faces of blue, green, and bright red rock. They are also distinguished by a different vegetation.

Perak Valley.—The valley of the Perak River is bounded by the groups of mountains already described on the west; on the east by the Kinta Range, and north of the Plus by the Bukit Panjang Range. The river flows on the eastern side of the valley; this is owing to the many spurs and outliers on the eastern sides of Mounts Bubu and the Ijau Ranges. It seems as if there had been much less denudation on the eastern than on the western sides of the range. This may be owing to the prevailing rains falling more abundantly on the western than on the eastern sides of the mountains.

As a consequence of this the tin workings appear to be, with little exception, on the western sides of the ranges, where the waste and wash has probably been greater.

Batu Kurau.—Between Mount Bubu Range and Mount Ijau Range and the sea there are no hills except small outliers, mostly of Palæozoic clay, which have evidently belonged to the ranges. But north of the Larut River there is an isolated limestone mountain near the Kurau River. This is called Batu (stone or rock in Malay) Kurau. It is very similar to Mount Poudok in the Gapis Pass. It is quite unconnected with the main range, and rises out of the plain between the spurs which form the valley of the Kurau River. There is also a small detached range dividing the valley of the Krian River from that of the Kurau.

Main Range.—Of the main range I know but very little from personal observation, having only visited it at Goping, and at the limestone hills, where the tin is worked on the Diepang River. But I have travelled along the most of the Kinta Valley skirting the base of the range either on foot or in boats. I have also traced the valley of the Kampar River. The geology is like the rest of the country, mainly granite, slates, and limestone, with traces of basaltic rocks. The general structure of the range can best be judged from some of the mountains to the westward. It forms a most imposing boundary to the whole of the western horizon. In the north, about the sources of the Plus River, there is a mountain of rounded outline, probably over 6000 feet high. The range there declines a little, with a somewhat serrated outline, but generally over 3000 feet. At a point corresponding with the latitude of about the centre of the Kinta Range, or opposite the Gapis Pass, the chain increases in elevation to perhaps over 5000 feet, and in the distance is seen a peak which must be over 8000 feet high. I know no name for this hill, but it is the most distant mountain usually seen. South and west of this the chain rises into a grand cluster of peaks, the highest of which is over 7000 feet. This is Gunong Robinson. It looks higher than the Sugar-Loaf Hill as seen from Gunong Bubu, but then it is much nearer. From Gunong Robinson the range declines to the southward, but is still a bold series of picturesque peaks, many of which must be over 6000 feet. It has been asserted by more than one observer that to the south of the point where the range is lost sight of from Arung Pura, there is a high mountain occasionally visible higher than any other in the main range, and probably over 12,000 feet. This I have not seen, but I am convinced that there are many things yet to be learned about the most elevated portions of this mountain chain. Seen from any point of view, it forms a magnificent mountain prospect. Its mysterious unexplored recesses are rendered more gloomy than any scene in the world from the dense forest and the masses of vapour and cloud with which they are always clothed. A few savage Sakies are the only inhabitants. I may add that perhaps in no country in the world is exploration rendered so difficult from the extraordinary thickness of the jungle and the steepness of the mountain ridges which unceasingly cross the traveller's path.

Penang, September 8 J. E. TENISON-WOODS

A NEW APPLICATION OF SCIENCE

DR. FERRIER'S researches on the brain, to which we have often drawn attention in these columns, have lately received an application of the most startling character. What this application is cannot be better stated now than in the accompanying letter, signed "F.R.S.," which appeared in Tuesday's *Times*. We shall return to this subject next week.

"While the Bishop of Oxford and Prof. Ruskin were, on somewhat intangible grounds, denouncing vivisection at Oxford last Tuesday afternoon, there sat at one of the windows of the Hospital for Epilepsy and Paralysis, in Regent's Park, in an invalid chair, propped up with pillows, pale and careworn, but with a hopeful smile on his face, a man who could have spoken a really pertinent word upon the subject, and told the right rev. prelate and the great art critic that he owed his life, and his wife and children their rescue from bereavement and penury, to some of these experiments on living animals which they so roundly condemned. The case of this man has been watched with intense interest by the medical profession, for it is of an unique description, and inaugurates a new era in cerebral surgery; and now that it has been brought to a successful issue, it seems desirable that a brief outline of it should be placed before the general public, because it illustrates vividly the benefits that physiological explorations may confer on mankind, shows how speedily useful fruit may be gathered from researches undertaken in the pursuit of knowledge and with no immediate practical aim, and reveals

impressively the precision and veracity of modern medical science.

"This case, then—this impressive and illustrative case—is that of a man who, when admitted to the Hospital for Epilepsy and Paralysis, presented a group of symptoms which pointed to tumour of the brain—a distressing and hitherto necessarily fatal malady, for the diagnosis or recognition of which we are indebted to bed-side experience and post-mortem examination. But while clinical and pathological observations have supplied us with knowledge which enables us to detect the existence of tumours of the brain, they have not afforded us any clue to the situation of these morbid growths in the brain mass, and it was not until Prof. Ferrier had, by his experiments on animals, demonstrated the localisation of sensory and motor functions in the cerebral hemispheres that the position of any diseased process by which they might be invaded could be definitely determined. By the light of these experiments it is now possible in many instances to map out the seat of certain pathological changes in these hemispheres with as much nicety and certainty as if the skull and its coverings and linings had become transparent, so that the surface of the brain was exposed to direct inspection. And thus in the case to which I am referring, Dr. Hughes Bennett, under whose care the patient was, guided by Ferrier's experiments, skilfully interpreted the palsies and convulsive movements which the man exhibited, and deduced from them that a small tumour was lodged at one particular point in his "dome of thought," and was silently and relentlessly eating its way into surrounding textures. Not more surely do the fidgetings of the electric needle intimate their origin and convey a meaning to the telegraph clerk than did the twitchings of this man's muscles announce to Dr. Hughes Bennett that a tumour of limited dimensions was ensconced at a particular point of a particular fold or convolution of the brain—the ascending frontal convolution on the right side.

"Very brilliant diagnosis this, it may be remarked, and nothing more. A conclusion has been arrived at which, should it prove correct, will gratify professional pride; but as it cannot be confirmed or refuted until the poor patient is no longer interested in the matter, and cannot be made the basis of any active interference, no great advance has been made after all, and vivisection has yielded only some barren knowledge. Until quite recently, criticism of this kind would have been justifiable in a sense, but now it is happily no longer possible, for another series of experiments on living animals, undertaken by Profs. Ferrier and Yeo, have proved that through our power of localising brain lesions we may open a gateway for their removal or relief. The old notion that the brain is an inviolable organ with *noli me tangere* for its motto—a mysterious and secluded oracle of God that simply falls down and dies when its fane is desecrated by intrusion—has been dissipated by these experiments; and we now know that under punctilious antiseptic precautions the brain, in the lower animals at any rate, may be submitted to various operative procedures without risk to life or fear of permanent injury. Emboldened by this knowledge, Dr. Hughes Bennett devised a way of helping his patient whose disease he had diagnosed with such remarkable exactitude, and gave him one chance, if he had the courage to embrace it, of saving his life and recovering his health.

"The patient had the position in which he stood faithfully explained to him. He was told that he laboured under a malady which medicines were powerless to touch, and that if left unassisted he must die in a few months at latest, after prolonged sufferings similar to those which had already brought him to the verge of exhaustion, and which could be only partially alleviated by drugs; but that one outlet of escape, narrow and dangerous, but still an outlet, was open to him in an operation of a formidable nature and never before performed on a human being, under which he might, perhaps, sink and die, but from which he might, perhaps, obtain complete relief. The man, who had faith in his doctor, and no fine-spun scruples about availing himself of the results of vivisectional discoveries, eagerly chose the operation. On the 25th ult. accordingly, Mr. Godlee, surgeon to University College Hospital, in the midst of an earnest and anxious band of medical men, made an opening in the scalp, skull, and brain membranes of this man at the point where Dr. Hughes Bennett had placed his divining finger, the point corresponding with the convolution where he declared the peccant body to be, and where sure enough it was discovered. In the substance of the brain, exactly where Dr. Hughes Bennett had predicted, a tumour, the size of a walnut was found—a tumour which Mr. Godlee removed without difficulty. The man is now convalescent, having never had a bad symptom, and full of gratitude for the relief afforded him. He has been snatched from the grave and from much suffering, and there is a good prospect that he will be restored to a life of comfort and usefulness. In that case he will be a living monument of the value of vivisection. The medical profession will declare with one voice that he owes his life to Ferrier's experiments, without which it would have been impossible to localise his malady or attempt its removal, and that his case opens up new and far-reaching vistas of hopefulness in brain-surgery. Many men and women will henceforth, there is reason to anticipate, be saved from prolonged torture and death by a kind of treatment that has been made practicable by the sacrifice, under anæsthetics, of a few rabbits and monkeys."

NOTES

The Council of the British Association for the Advancement of Science has requested the following to allow themselves to be nominated as Presidents of Sections for the meeting at Aberdeen, which begins on Wednesday, September 9, 1885:—Section A (Mathematics, &c.), Prof. J. C. Adams; Section B (Chemistry), Prof. Armstrong; Section C (Geology), Prof. Judd; Section D (Biology), Prof. McIntosh; Section E (Geography), General Walker; Section F (Economics), Prof. J. Bryce; Section G (Mechanics), Mr. B. Baker; Section H (Anthropology), Mr. F. Galton.

We learn with pleasure that M. Mascart was on Monday last elected a Member of the Academie des Sciences, Paris.

The Berkeley Research Fellowship has been given by Owens College, Manchester, to Mr. G. H. Fowler of Keble College, Oxford. An opportunity is thus given to Mr. Fowler of carrying on his work on the anatomy of the Zoantharian corals.

The immense economical importance of Government botanic gardens, especially in young colonies, is well shown by the last report of the Curator of the Gardens in Brisbane. Omitting the distribution of ornamental trees, shrubs, &c., to the gardens of public institutions, as well as that of ornamental pot plants, we find that economic plants have been distributed on a very large scale. The demand for these has been unprecedentedly large, and no application is ever refused so far as it can be supplied. About 3000 economic plants were sent out during the year; these consisted chiefly of various kinds of coffee, tea, cocoa (*Theobroma cacao*), cinchona, and vanilla. Grafted Indian mangoes and plants of the Brazilian nut (*Bertholletia excelsa*) have been given to likely growers, and the demand for the latter is so great that application has been made to the universal feeder of these institutions, Kew, for more. Besides acting as a collecting and distributing agency, the Brisbane Gardens do what is perhaps of even more value, viz. ascertain by experiment the conditions under which certain foreign plants will grow best in the colony. The most important trials recently have been with regard to cinchona, which, Mr. Pink shows, may by care in its early stages, be successfully cultivated in Queensland. The hop plant has been tried, and appears a success, 10 cwt. being the produce per acre the first season, while in England under similar circumstances it is only 4 cwt. Sugar is at present the staple of the colony, but no efforts are spared to discover new kinds elsewhere which may be better adapted to the place. 100 tons of various kinds of cane, chiefly from Mauritius, were sent to planters during the year. Economic and valuable timbers also receive much attention, and the gardens have now ready for transplanting 20,000 trees of various kinds, including cedars, olives, silky oak, English oak, English ash, poplars, and chestnuts. The recent experiments have conclusively shown that Queensland can introduce among her staple produce-crops such valuable and remunerative products of the soil as coffee, hops,

and cinchona. As an example of the care and labour devoted to the work, it may be mentioned that every method of cultivating the cinchona in Ceylon and South America was tried in the gardens without much success; and finally Mr. Pink was compelled to devise a method of his own, which proved successful.

We regret to announce the death of Dr. Heinrich Bodinus, for many years Director of the Berlin Zoological Gardens; he died at Berlin on November 23 last. Also of Dr. Karl von Vierordt, formerly Professor of Physiology at Tübingen University; he died at that place on November 22, aged sixty-seven.

La Nature records the death of M. Henri Lortigue, to whom is due the practical introduction of the telephone in most of the large towns in France, and who was in many other respects a man of scientific note. In 1855 he was employed by Leverrier, the Director of the Paris Observatory, who was then organising a series of meteorological observations, to superintend the instruments by which, by means of photography and electricity, the slightest variations of the barometer, thermometer, and compass were recorded. In 1859 M. Lortigue took charge of the telegraph service on the Chemin de Fer du Nord, and received a gold medal for his various inventions of semaphores, automatic whistles, &c. In 1880 he was Director of the Société des Téléphones. He was also a botanist and entomologist of note, and has left behind him some excellent collections in natural history.

The part of Turkestan bordering on China and comprising the countries retroceded by Russia, is now entirely incorporated with the Chinese Empire, and will form henceforward the 19th Province.

We have received from Messrs. Collins of Glasgow the new edition (twentieth thousand) of Prof. Guthrie's well-known "Text-Book of Magnetism and Electricity." Not only has the present edition been carefully revised, but it contains a supplementary chapter by Mr. C. V. Boys, referring chiefly to the practical applications which have been made of electricity during the last few years, such as the telephone and microphone, dynamo machines, electric light, secondary batteries, &c. Electric and magnetic units are also referred to at some length.

Our readers will be glad to know that the Fine Art Society announces the publication of an etching of Prof. T. H. Huxley, after the picture painted by Mr. John Collier, which was exhibited at the Royal Academy in 1883. The etching is the work of the distinguished etcher, M. Léopold Flameng, and corresponds in size with the portrait of the late Mr. Charles Darwin, painted and etched by the same artists, and published by the same Society last year.

An examination of a series of water-marks set in 1750 all round the Swedish coasts, from the mouth of the Tornea to the Naze, in order to settle a dispute between the Swedish astronomer Celsius and some Germans, as to whether the level of the Baltic has been rising or sinking, shows that both parties were right. The gauges were renewed in 1851, and again this year, and have been inspected regularly at short intervals, the observations being carefully recorded. It appears that the Swedish coast has been steadily rising, while that on the southern fringe of the Baltic has been as steadily falling. The dividing line, along which no change is perceptible, passes from Sweden to the Schleswig-Holstein coast, over Bornholm and Laland. The results have lately been published by the Swedish Academy of Sciences; and it appears from them that while during this period of 134 years the northern part of Sweden has risen about 7 feet, the rate of elevation gradually declines as we go southwards, being only about 1 foot at the Naze, and nothing at Bornholm, which remains at the same level as in the middle of the last century. The general average result would be that the Swedish coast has risen about 56 inches during the last 134 years.

The Central Geodynamic Observatory at Rome recently received notice from Corleone, in the province of Palermo, of another violent shock of earthquake, making the fourth in Italy in less than a fortnight. The first occurred on November 23, at 7.30 p.m., on the eastern slope of the Western Alps, and coincided with the reawakening of Vesuvius. The second, at midnight on the 27th, extended from the same region to Switzerland and Lyms on the north, and to the Liguarian coast of Italy. The third, at midnight on the 29th, shook Cosenza and Paola in Calabria. The fourth touched Sicily at Corleone at four o'clock in the afternoon of the 5th inst. During this period an unusual agitation had been noted in the seismographic instruments at Rome and elsewhere in Italy. Prof. Di Rossi, Director of the Geodynamic Observatory, announces the early publication of very interesting observations taken at Rocca di Papa, comprising the alterations in level, and in the temperature of subterranean waters.

A notice has just been received from M. Hepites, who has long been carrying on meteorological observations in Roumania, to the effect that the Roumanian Government has decided on the establishment of a meteorological organisation, and has voted the necessary funds. The Central Institute is being built at Bucharest. The organisation was started July 1. M. Hepites is the director.

In a paper recently read before the Shanghai branch of the Royal Asiatic Society, Dr. Macgowan affirms the claims of the Chinese to be the originators of gunpowder and firearms. This claim was examined in an elaborate paper some years ago by the late Mr. Mayers, and decided by him in the negative. Dr. Macgowan admits that gunpowder as now used is a European discovery. Anterior to its granulation by Schwartz it was a crude compound, of little use in propelling missiles; this, says the writer, is the article first used in China. The incendiary materials stated by a Greek historian to have been employed by the Hindus against Alexander's army, are stated to have been merely the naphthous or petroleum mixtures of the ancient Coreans, and in early times used by the Chinese. The "stink-pots," so much used by Chinese pirates, is, it appears, a Cambodian invention. Dr. Macgowan states also that as early as the twelfth or thirteenth century the Chinese attempted submarine warfare, contriving rude torpedoes for that purpose. In the year 1000 an inventor exhibited to the then Emperor of China "a fire-gun and a fire-bomb." He says that while the Chinese discovered the explosive nature of nitre, sulphur, and charcoal in combination, they were laggards in its application, from inability to perfect its manufacture, so, in the use of firearms, failing to prosecute experiment, they are found behind in the matter of scientific gunnery.

In *The Hull Quarterly and East Riding Portfolio*, edited by W. G. B. Page, Sub-Librarian of Subscription Library, Hull, will appear, during the year 1885, interesting articles by T. M. Evans, President of the Literary and Philosophical Society, Hull, on the ancient Britons and the lake-dwelling at Ulrome in Holderness; A. C. Hurtzig, C.E., on some tidal and engineering features of the River Humber: and William Lawton, on the meteorology of Hull.

The Leicester "Literary and Philosophical," now entering upon its jubilee year, appears to be a flourishing society in a flourishing town. Over 300 members distribute themselves into five sections, containing many ladies as Associates, and both making outdoor excursions for practical observation, and holding evening meetings at which lectures are given, professional as well as amateur, followed at the latter by discussions. These lead to the collection and distribution of valuable knowledge of archæology, literature, and economics; of astronomy, physics,

and chemistry; of geology, where the exposures made by local railway cuttings are carefully studied and recorded; of biology (combining botany and zoology); and of zoology, specially directed to the study of the animals of the county, a list of which will be published as it approaches completeness. Some of these productions are not among the abstracts at the end of the Report, being reserved for publication in "another place." These papers are read in a new lecture-hall adjoining the Museum, another institution which, though not very extensive, is in a most active state of growth and improvement. A new curator has led to a thorough rearrangement of the zoological collection in such cases and surroundings as show the specimens in their natural habitats, with index sketches attached to each case, supplying names, &c., hanging near. So large an outlay has been made upon these cases, that only 4 per cent. of the expenditure has been devoted to fresh objects. A large increase in the number of visitors has followed these reforms, and nothing, we venture to say, would so increase the attendance at a museum as the introduction of variation instead of rigid order, and the contributions from South Kensington can best assist in this "movement." It seems hardly possible than an institution like this should be frequented by persons engaged in business when the hours of opening it are only the middle hours of the business day, viz. from ten till four, and the fact that on a holiday like Whitsun Monday 97 persons per hour were admitted during the daytime, and 353 persons per hour were admitted in the evening, shows that, here at any rate, the latter hours are the favourite hours also. Why, on the same ground, should a series of "popular" lecturettes be given at three o'clock in the afternoon?

Dr. A. Penck has recently studied the old glaciers of the Pyrenees in detail, and has found remarkable differences between them and the Alpine glaciers of the Ice period. Even at that remote period the Pyrenean glaciers were of far smaller extent than those of the Alps—in the western part of the Pyrenees indeed there existed not a single one. Wherever traces of glaciers could be found they were accompanied by lake beds; these have by now been filled up for the greatest part, at least in the lower altitudes, the only lakes still existing being situated in altitudes of between 1500 and 3000 metres.

We have received a pamphlet on the climatic conditions of Luxor and Egypt, with especial reference to invalids, by Dr. Maclean (H. K. Lewis). The author spent three years as an invalid and also in the practice of his profession in Egypt. There are several meteorological tables and diagrams, and very much information of all kinds for the traveller, although the traveller who wants to escape the English winter is the special object of the writer's solicitude.

Prof. Lindström, the keeper of the palæontological collections at the Stockholm Museum, has made an interesting discovery amongst a number of petrefacts obtained from the Island of Gothland. It is an air-breathing crustacean from the Silurian period, the first specimen of the kind yet found.

Prof. Gustav von Hayek, the author of the well-known "Atlas of Natural History" (published by Perles of Vienna), has received the gold medal for arts and sciences from the Emperor of Austria, in recognition of the excellence of the work referred to.

We learn from *Science* that Commander Bartlett's annual report on the operations of the U.S. Hydrographic Office makes a good showing for activity and enterprise. Lists of light-houses and "Notices to Mariners," in which bearings are given in degrees from true north, instead of magnetic bearings in points, as formerly, have been liberally published; the official correspondence with other hydrographic offices has been increased; and a complete set of the charts issued by all nations is kept on file, and is always at the service of the public for the determination of any questions relating to hydrography. The only vessel engaged in making surveys during the year was the *Ranger*, on the west coast of Mexico and Central America; but it is strongly recommended that new surveys be undertaken in several regions where they have long been wanted. The charts of the northern coast of South America are mostly based on old Spanish surveys dating back to 1794. "Watson's Rock," latitude 40° 17′ N., longitude 53° 22′ W., in the path of North Atlantic traders, has been reported so many times that its existence ought to be definitely settled or unsettled. The recommendation of previous hydrographers with regard to surveys of the Caroline and Marshall Islands, in the equatorial Pacific, should no longer be neglected; they lie in the belt of the trade-winds and westerly current, the natural highway of vessels crossing the ocean to Japan, China, and the East Indies, and require immediate examination. In the North Pacific alone there are over 3000 reported dangers that need decisive observation. In many cases the same island has half a dozen different positions, with as much as fifty miles between the extremes. It is urged that every naval vessel be provided with modern sounding-apparatus, by which even deep-sea measures can be quickly made, and required to sound wherever the charts show no depths reported within twenty miles on any side; and it is desired that a ship should be fitted out expressly to make investigations into ocean temperatures at all depths, and thus obtain data necessary to complete the determination of the actual oceanic circulation.

M. Guinet, a rich burgher of Lyons, having spent some years of his life and 200,000*l.* of his money in the erection and furnishing of a museum, recently opened in his native town, intended to illustrate the religions of the East, has further applied to have the establishment transferred to Paris, where it would be likely to interest and instruct a larger number of visitors. He has, in addition, offered to consign the whole into the hands of the Government under certain conditions, an offer which has been accepted. A number of priests belonging to the Buddhist and Brahmanic religions are to be brought to Paris, and at fixed salaries employed in translating historical and liturgical books connected with their respective faiths.

The French Government have bestowed fresh honours on the officers of the Meudon steering balloon, one of them having had his name put down on the list for the distinction of a "Chef de Bataillon," while another has been made a knight of the "Légion d'Honneur," and a third, who was wounded in preparing the hydrogen gas, has had the same distinction awarded him. At the same time that we observe the services of these gallant officers so well appreciated, we learn that the steering balloon has been dismantled without undergoing any new experiments, nor do we hear that the Commission appointed by the Academy of Sciences to report on the balloon has published any verdict respecting it.

The Municipal Council of Paris having been called on to vote on the question of a site for the Centennial Exhibition of 1889, have selected the Champ de Mars, the ground on which former exhibitions were held. This unexpected vote on a matter to which in the circumstances of the case great importance was attached has caused a considerable amount of sensation.

"Celsus and his Works" was the subject of the first of a course of lectures during the current session, delivered at the Faculty of Medicine in Paris, by M. Laboulbène. The course is to be devoted to a history of the principal discoveries in medicine and surgery, and the lectures are to appear in the *Revue Scientifique*.

A COMMISSION has been appointed by M. Cochery to determine the conditions of security requisite for laying electric cables to transmit currents of high tension. This step has been taken in connection with the experiments conducted at Creil and the Gare du Nord with the Marcel-Deprez system, as well as others which may be in preparation.

THE observer at the meteorological station on the summit of the Obir (Carinthia) reports that on October 11, at 8.15 p.m., he saw a beautiful display of St. Elmo's fire. The points of the vanes, the telephone wires, and the tops of the posts supporting this wire shone brilliantly in a whitish-blue light.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♀), a Macaque Monkey (*Macacus cynomolgus* ♂) from India, presented by Mr. John Roberts; a Bonnet Monkey (*Macacus sinicus* ♂) from India, presented by Mr. David McCance; a Montagu's Harrier (*Circus cineraceus*), European, presented by Lord Lilford, F.Z.S.; a Banded Gymnogene (*Polyboroides typicus*) from West Africa, a Gold Pheasant (*Thaumalea picta* ♂) from China, an Indian Python (*Python molurus*) from India, deposited; three Lions (*Felis leo*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE BINARY STAR α CENTAURI.—In the last number of the *Monthly Notices* of the Royal Astronomical Society, Mr. E. B. Powell, so favourably known for his excellent measures of double-stars, made during his residence in India, has a note in which he gives reasons for concluding that the period of revolution of this most interesting binary is longer than has been assigned by the later calculations of its orbit, and, instead of a period of 77½ years, which is about that found by Dr. Elkin, he considers that one of 86 or 87 years is better supported by the earlier observations, viz. those by Richaud at Pondicherry in December, 1689, and by Feuillée at Lima on July 4, 1709. The results of an investigation by Dr. Doberck, communicated to the writer early in 1879, rather tend to support Mr. Powell's conclusion. Dr. Doberck's elements, which are professedly only provisional ones, are as follow:—

Periastron passage	1875·12
	° ′
Node	25 32
Angle between the lines of nodes and apsides	45 58
Inclination	79 24
Excentricity	0·5332
Semi-axis major	18″·45
Period of revolution	88·536 years.

In this orbit the angle and distance at the epochs of the observations of Richaud and Feuillée would be:—

1689·95	Position, 14°·9	Distance, 9′·54
1709·51	,, 200·8	,, 14·74

ENCKE'S COMET.—The elements of this comet for the approaching perihelion passage are as follow, according to the calculations of Dr. O. Backlund of Pulkowa:—

Perihelion passage 1885, March 7·6523 G.M.T.

Longitude of perihelion	158° 32′ 45″·0	Mean Equinox 1885·0
,, ascending node	334 36 54·6	
Inclination	12 54 0·1	
Angle of excentricity	57 45 20·5	
Mean daily sidereal motion	1072″·97311	

The corresponding period of revolution is 1207·86 days. An ephemeris for January will appear next week.

BARNARD'S COMET.—Prof. Frisby of Washington has calculated elliptical elements of this comet from observations made at the Naval Observatory between August 12 and October 20, and therefore extending over sixty-nine days. The period of revolution in his orbit is 1878·65 days, or 5·143 years, but this element does not appear to be as yet very closely determined, much less so indeed than in the case of the second new comet of short period detected during the present year by Wolf. In Prof. Frisby's orbit the distance of the comet at aphelion from the orbit of Jupiter would be 0·705, the aphelion distance being 4·683, therefore considerably within the orbit of the planet; at the ascending node the comet's distance from the sun would be 1·552, and at the opposite node 3·942. Taking these conditions into account, it would appear probable that it has been long moving in its actual orbit. The comet, however, belongs most likely to the fainter class of those revolving in short periods, and in the present year has been observed under somewhat favourable circumstances: it approaches nearest to the earth when the perihelion passage takes place between a fortnight and three weeks earlier than in 1884. On November 20, M. Perrotin observing with the Gauthier-Eichens equatorial of the Observatory of Nice, aperture 0·38 m., found the comet near the limit of vision for that instrument; he remarks:—"Pour la rendre sensible à l'œil et bien saisir sa position exacte, on était obligé d'agiter legèrement la lunette en ascension droite, tantôt dans un sens, tantot dans l'autre." The position determined for that evening was as follows:—

Nov. 20 at 7h. 25m. 38s. Nice M.T. R.A. 22h. 38m. 21·85s., N.P.D. 97° 18′ 20″·4.

The Observatory of Nice (Mont-Gros), established through the munificence of M. Bischoffsheim of Paris, is in longitude 0h. 29m. 12·2s. east of Greenwich, and in latitude 43 43′ 16″·7.

GEOGRAPHICAL NOTES

THE correspondent of the *Times* with the Afghan Boundary Commission, writing from Khwaja Ali on October 16, describes the march of the expedition from Quetta to the Helmand. The geologist, Mr. Griesbach, describes the geological features of the country as much the same as those seen in the Pishin and Candahar country, viz. steep, deeply-eroded mountain ranges with a general strike of north, south to north-east, south-west, the intervening valleys being filled by Post-Tertiary deposits, which form extensive plains and glacis. The ranges of hills are more or less continuations of ranges, which are crossed by the Quetta-Candahar road. After leaving Kanak, one crosses the south-western end of the Ghaziaband range, which is composed of sandstone, shales, and grits of the "flysch" facies of the Eocene rocks. Beyond that range one enters the southern extension of the Lora plain of the Pishin. The white and coloured clays of the Siwaliks, seen from Dina Karez in the Pishin, are again seen (afar off) from Panjpai, and no doubt they underlie most of the Post-Tertiary deposits which form the surface of these wide valleys). The low ridges between Panjpai and Nushki are composed of sandstones, flaggy limestone beds, and friable shale, identical with the "Soliman" sandstone, and entirely belonging to the Lower Cretaceous series. The contact between the hippuritic limestone and the trap contains in the Candahar district gold (with traces of nickel) and galena ores. The water found below the surface is the natural drainage from the hills, contained in the gravels and sands of the Post-Tertiary fan deposits, inclosed between the clays of the Siwaliks below, and the recent conglomerate (a kind of kankar) above.

DR. CHAVANNE, who visited the Congo by order of the Brussels Geographical Society, has returned to Lisbon for a short period in order to recruit his health, which has suffered by the tropical climate.—Herr Flegel, who was preparing for a new expedition into the Benué districts, is also detained in Europe by ill health.—The Russian traveller, M. Piasecki, well known through his travels in China in 1874, is about to start on another exploring expedition to that country under the patronage of the Emperor of Russia and the Grand Duke Wladimir.

IN a recent number of the *Revue Scientifique* there is a long article by M. L. Simonin, on the geography of China. The area of the whole Empire of China is estimated at 11,574,356 square kilometres, *i.e.* the largest empire in the world next to that of Russia, which is 21,702, 230 square kilometres. China proper, however, is only 4,024, 690 square kilometres, *i.e.* two-fifths of Europe, seven times the size of France, and fifteen times that of Great Britain. With regard to the population of China it is not possible to give precise and absolutely trustworthy numbers, there being no proper official census in force in the Empire. The statistician of the Imperial Chinese Customs sets down the actual population of China at 250,000,000. A census drawn up in 1882 for fiscal purposes, and cited by the United States Minister in China, gives 255,000,000 as the number of the population. In the lower basin of the Yang-tse-Kiang as

many as 420 people are to be found crowded within the limits of one square kilometre. The total debt of the Government is reckoned at 266,000,000 francs, of which 214,000,000 francs have been contracted within the Empire itself, leaving only 52,000,000 francs of foreign debt. The army is composed of two large bodies: the Tartar army, including the Manchoos and the Mongols; and second, the Chinese army. The Tartar army, guarding Pekin, the frontiers, and the coast, comprises the army of Manchooria of 30,000 men, the Mongolian army of 20,000 men, the Turkestan army of 40,000, and lastly the army occupying the maritime provinces, numbering 100,000. The Chinese army proper is distributed throughout the eighteen provinces, and performs the functions of police in addition to its military duties. Its number ranges from 20,000 to 100,000 in each province, according to its population and its defensive requirements. The navy in 1879 was estimated to comprise fifty-six ships armed with 283 guns, and manned by 5860 marines. Since that date, however, the fleet has been largely developed.

L'Exploration states that the Geographical Society of Amsterdam is about to acquire the fac-simile of the most ancient map known, and which represents the Roman Empire as it was in the time of Augustus. It is formed of eleven folding maps, which make one large map 8½ metres in length. The original is in the Royal Library at Vienna, which purchased it in the sixteenth century from the estate of Conrad Peutinger of Augsburg, a circumstance which gave the map its name of *Tabula Peutingeriana*. Peutinger purchased it for 40 ducats. The original, which is dated 1265, was the work of a Dominican monk of Colmar.

THE deaths are announced of two Italian geographers and travellers, Eugenio Balbi and Carlo Guarmani. The former was the son of the celebrated Adrien Balbi, and was born at Florence in 1812. After several years' travel in Europe, he finally returned to Italy, where he devoted all his energy to the study of ethnography and geographical science. His principal works are: "Gea"; "I monumenti della geografia nell' evo medio e moderno"; "L'Italia nei suoi naturali confini." Guarmani had travelled widely, and in his last years was one of the correspondents of the geographical review of Milan, *L'Esploratore*.

THE Institute of Argentine Geography has decided to organise an expedition into the Andes of Patagonia. The explorers will leave Lake Nahuel-Huapi, and will then undertake a detailed investigation from a geographical point of view of the Argentine slope of the Andes, following it to the Straits of Magellan. The head of the expedition will be Capt. Moyano, who has been instructed to present a report to the Institute at the earliest possible date, indicating the plan of work, the instruments, and other objects necessary, as well as an approximate estimate of the expense. The Federal Government will be requested to grant the co operation of the troops stationed on the frontiers of Limay, as well as to send a sloop-of-war to act where possible in concert with the expedition.

A TEACHING UNIVERSITY FOR LONDON

IN connection with our leading article this week we append the following Plan for Promoting a Teaching University for London, which was discussed at the meeting:—

A sub-committee was appointed on Monday, November 10, to draw up a plan, in accordance with the objects of the Association for promoting a Teaching University which are as follows:—(1) The organisation of University Teaching in and for London, in the form of a Teaching University, with Faculties of Arts, Science, Medicine, and Laws. (2) The association of University Examination with University Teaching, and direction of both by the same authorities. (3) The conferring of a substantive voice in the government of the University upon those engaged in the work of University Teaching and Examination. (4) Existing Institutions in London, of University rank, not to be abolished or ignored, but to be taken as the bases or component parts of the University, and either partially or completely incorporated, with the minimum of internal change. (5) An alliance to be established between the University and the Professional Corporations, the Council of Legal Education as representing the Inns of Court, and the Royal Colleges of Physicians and of Surgeons of London.

The Sub-Committee, consisting of Lord Reay, Chairman, Prof. John Marshall, F.R.S., Ex-P.R.C.S., Dr. W. M. Ord, F.R.C.P., Mr. F. Pollock, Barrister-at-Law, Mr. R. S. Poole, British Museum. Dr. P. H. Pye Smith, F.R.C.P., Prof. G. C. W. Warr, King's College, Prof. A. W. Williamson, University College, and Sir George Young, met and considered the subject of reference, and submitted the following proposed plan of a Teaching University for London for the consideration of the Committee, on Monday, the 15th inst.:—

(*a*) THE CONSTITUTION OF THE TEACHING UNIVERSITY.—To be founded on (1) the *Faculties* or Constituent Bodies; (2) a *Board of Studies* for each Faculty; (3) a Governing Body or *Council*.

(1) *The Council.*—To consist of Members representative of—

(*a*) The several Faculties. The proportion of representatives of the Faculties to the whole number of the Council to be at least one-third.

(*b*) The Senate of the University of London.

(*c*) The Council of Legal Education.

(*d*) The Royal Colleges of Physicians and of Surgeons.

(*e*) It should be a point for future consideration whether other Public Bodies should be directly represented on the Council, *e.g.*, the Authorities of the British Museum, of the Royal Academy and Royal Society, of the Incorporated Law Society, and of the Institute of Civil Engineers.

(*f*) Colleges and other Educational Institutions associated with the University. The amount of representation and the qualification for direct representation on the Council to be determined, in each case, having regard both to the nature and the amount of the educational work performed by the Associated Institution.

(*g*) Endowing Bodies, *e.g.*, the Crown, if the Teaching University should receive State endowment; the Corporation and Companies of the City of London, if they contribute to endow the University.

Representatives of Associated Institutions and Endowing Bodies not to exceed one-third of the whole number of places on the Council.

(2) *The Boards of Studies.*—To be elected by each Faculty. Some additional Members might be appointed by the Council. The Board to advise in all matters relating to the Faculty, and to exercise authority in such matters as are delegated to it by the Council. Facilities to be provided for joint meetings and action of two or more Boards of Studies when necessary. The Board to appoint some or all of the representatives of the Faculty upon the Council. If any are appointed by the Faculty direct, they should also be *ex officio* Members of the Board.

(3) *The Faculties.*—To consist for electing purposes of—

(*a*) Teachers: being Professors, Lecturers, or persons of equivalent standing, in the Colleges or Educational Institutions associated with the University.

(*b*) Examiners for the time being in the Teaching University and in the existing University.

(*c*) Additional Members, to be appointed by the Council, on the recommendation of the Board of Studies.

There might also be Honorary Members of Faculties, including Graduates in that Faculty, of the Teaching University; Members of Convocation of the existing University according to their Degrees; recipients of degrees *honoris causâ*, and so forth; such Honorary Members having the right to attend and vote only at a General Meeting of the Faculty, to be summoned on requisition when necessary.

(*b*) RELATIONS OF THE TEACHING UNIVERSITY WITH OTHER BODIES.—(1) *The Existing University.*—There might be one Chancellor, with two Vice-Chancellors, the Teaching University and existing University constituting one University in two departments. The Degrees might, if necessary, be distinguished by their designation in some suitable manner. The Senate of the existing University would remain unaltered, would be appointed as at present, and would control the present Examinations and confer Degrees, without interference. Convocation might accept the Graduates of the Teaching University as full Members. The Teaching University might, so far as is practicable, find a place of meeting at Burlington House, together with the existing University.

(2) *The Professional Corporations.*—Degrees in Law, Medicine, and Surgery to be recognised as qualifying *pro tanto* for Call to the Bar or for Licence to practise, the power of Calling to the Bar or of conferring Licences to practise being reserved to the existing Authorities. The previous Examinations of the Teaching University to receive recognition by those Authorities, such as is now given to the Examinations of existing Universities.

(3) *Colleges, Educational Institutions, Special Schools, and Institutions for Purposes of Research.*—Each Associated Institution to remain unaffected in any way, save in so far as it might be willing to adopt the recommendations of the University Council.

The School of Law of the four Inns of Court to be an Associated Institution, and its Professors and Examiners to be Members of the Faculty of Law, but without further direct representation on the Council than that already given to the Council of Legal Education.

The recognised Hospital Schools of London to be Associated Institutions, and their Professors and Lecturers to be Members of the Faculty of Medicine.

The direct representation of the Hospital Schools on the Council being difficult, owing to their number, it might be provided that they should all have one representative, at least, on the Board of Studies of the Medical Faculty.

Schools of Fine Art and Technical Schools employing Teachers, some of whom are not engaged in what can be called, strictly speaking, University work, if composing part of an Associated Institution, to be admissible as Special Schools of the University, and their principal Teachers to be Members of the appropriate Faculties.

Junior Schools forming part of Associated Institutions to be admissible similarly as Special Normal Schools, for the purpose of training Teachers.

Institutions for purposes of Research to be admissible as Special Schools, and their Principals or principal Members to be eligible as additional Members of the appropriate Faculty.

Educational Institutions, of which the work is either in kind or quantity insufficient to entitle them to rank as Associated Institutions, while at the same time partaking of a University character, to be similarly admissible as Special Schools.

(*c*) Work of the Teaching University.—The Teaching University to obtain power to confer the usual Degrees, either by way of supplemental Charter to the University of London or otherwise, after such course of study and examination as may be determined on.

As means and opportunity will allow, the Teaching University to appoint Professors in the more advanced studies, and for purposes of original research.

The Council to negotiate with Associated Institutions for the increase of facilities for common attendance at lectures, laboratory work, and admission to Libraries and Museums, and for the concentration of teaching within one or more of such Institutions, or within the University itself, in such studies as may appear desirable.

The extent to which it may be found possible to blend the examinations of the Teaching University with those of the existing University, of the Professional Corporations, or of other Examining Bodies, to be determined hereafter, full liberty of action being reserved to the respective Authorities.

Professors, Lecturers, &c., who are Members of the Faculty, to have the title of "——— Professor, Lecturer, &c., of (or on) ———" in the proposed University; the first blank denoting the College or Institution with which they are connected, preceded by the title (if any) by which their Chair or other office is known.

Students in Associated Institutions and Special Schools to be at liberty to become Undergraduates in the Teaching University, or to obtain Degrees as at present from the existing University.

Signed on behalf of the Sub-Committee,

Reay, *Chairman*

NATURE-DRAWING [1]

Before explaining the objects aimed at in the new drawing classes proposed to be formed in University College School, to be called Nature-Drawing Classes, let us look back and note briefly what we have achieved up to the present time, and gather if we can from it what kind of foundation we have for the work we are about to do, and what our necessities are in order to secure success. Of the past I am able to speak with some authority, having been connected with the drawing classes in this school for nearly forty years. That we have achieved a very considerable success is proved by the high position these classes are known to hold as compared with similar classes in other public schools; also by the fact that every boy who has taken the "Trevelyan Goodall Art Scholarship" in the school and has competed for the Slade Scholarships in the Slade Schools of Fine Art in University College has, without an exception, succeeded in securing the object of his ambition, and in the case where two of our boys were competitors at the same time, they succeeded in carrying off both scholarships, and all in competition with students older than themselves.

Now it is evident that such remarkable success must rest on some very sound foundation. Though there is no doubt that our method of teaching may account in part for this, and in no small part, yet by far the larger part of the foundation of this success has been laid by the zeal, energy, and intelligence in teaching displayed by the assistant drawing-masters, and I desire frankly, and without any reservation whatever, not only to acknowledge their signal ability and their right to the merit due from the results, but also to acknowledge my own indebtedness to their loyalty in giving effect and unity to the method of teaching, without which our success could never have been secured. The teaching has hitherto ranged from the drawing of simple geometrical forms to the drawing of the figure from the antique, together with mechanical drawing, model drawing, and perspective. And now I have a word for the younger boys, who, sometimes, may find the repeated drawing of curved and other lines a little wearisome, but they may rest assured that they are doing valuable work, and acquiring an invaluable power, for it is mainly in the combination of these curved lines, in the perception of their grace, and the power to render them accurately and freely, that the expression of the most beautiful form, and even the recognition of it, at length becomes possible.

That curriculum in our public schools is best which has the greatest elasticity, and is not bound so closely within the four walls of precedent that it is deprived of the power to expand in any direction to meet the necessities of the times. That the teaching of drawing in our public schools has not advanced adequately to meet these necessities will be, in most cases, frankly recognised by the teachers themselves. But the fault does not lie at their door. It is the "governing bodies" of our public schools, and the outside public, who are to blame. The past low estimate of both alike as to the utility of drawing as a serious study has proved the detriment to its advance. Both have recognised in drawing little more than a sort of harmless amusement to keep children out of mischief when not otherwise employed. Both have been blind to the influence which the imitation of beautiful forms must needs have on the minds of the young, and, yet more, to the influence it must have in after life. A love for beautiful form goes far towards making a beautiful life. While due effect is given to the utilitarian side of education, the æsthetic side cannot be ignored, but through literature and art the æsthetic phase of the student's mind should be developed as widely as possible, and, as a help to this, Prof. Huxley has publicly stated his conviction that it should be made *absolutely necessary* for everybody for a longer or a shorter period to learn to draw, and that there is nobody who cannot be made to draw more or less well.

It is proposed to arrange the new nature-drawing classes under two broad divisions, namely, landscape-art and science-art. Let us deal first with the proposed study of landscape-art, and, in order to make the direction these studies are to take the more clear, it were as well to state the direction they are not to take. They are not to take their direction on the old lines of making, in a blind, ignorant way, copies from the flat to be "finished off" by the more or less facile pencil of the master, and sent home *as the work of the pupil* at the close of the term. The influence of such palpable dishonesty can only be bad, and the more bad because of the openness with which the fraud is committed. It may be asserted that no fraud is intended, but is not almost every child sensible that there is a very real fraud, to which he has been made a party without his consent, when he shows his drawings and is praised for work he is well aware is not his own? Moreover, do you think he does not recognise how frequently and *easily* the fraud succeeds? But enough; let us dismiss it—it is bad. In the "nature-drawing" classes in University College School, landscape-drawing from the flat will be used only to secure with the pencil and the brush that *technique* absolutely needful. Concurrently, lessons will be given in the shape of lectures on natural phenomena, towards inducing a close, intelligent observation of them, in the belief that a boy will not draw an object—a cloud or a tree from Nature—any the worse, or with any the less interest, because he knows something about it, some scientific facts concerning it. Drawing is a record

[1] An address by W. H. Fisk, in part delivered at University College School, Gower Street, London.

of thought as well as of observation, and the measure of thought, as applied to form, is in exact ratio to the knowledge of the causes of it, and the knowledge of them the measure of intelligent delight in observing and recording their results. Accept this as a fact—*art cannot be divorced from science*, for it is science which teaches us to see truly, and by art we render the truth we see. In representing the human figure, this has been a recognised fact for perhaps over two thousand years. They who have drawn the figure finely have been earnest students of anatomy. Yet the anatomy of landscape-forms has been persistently ignored by all but a very few. The recognition of the anatomy of landscape as an art-study is a very modern recognition indeed. Yet to see truly in order to render truly is of as paramount importance in the representation of landscape as in that of the figure. Individual form is a correlation of scientific facts, a knowledge of which enables us to understand its structure and to imitate its appearance with correctness. It is mainly with these that we have to do if we would represent a mountain, a tree, a cloud. It is true that all forms are modified by their environment—by a ceaseless struggle with the varying conditions by which they are surrounded—while the modifications are the result of scientific facts as the forms themselves are. So, if we would represent objects *truly*, science alone can be our guide; for it is science which teaches us to see truly, not through the medium of our fancy, but through the exercise of our intelligence. Thus, for example, in these nature-drawing classes, the structural forms of mountains of granite, downs of chalk, hills of limestone, will be presented and explained side by side with the forms as they at present exist, and which are the results of modifications produced by persistent disintegration and denudation owing to the action of rains, frosts, winds, glaciers, streams, &c., during vast lapses of time. So with the structural forms of trees and their environment—whether of Coniferæ on the limits of the snow line; or trees in a dense forest-growth or on the outskirts of a wood; within the Arctic Circle or in tropical regions; affected by climatic extremes, by drought or excessive moisture; the free access of light or through its deficiency; by the repeated action of winds mainly in one direction distorting the tree, or their influence in many giving a healthy stimulus to the circulation of the sap.[1] It is needless further to pursue the explanation of the plan it is proposed to carry out in landscape-art; enough has been explained to make clear the object in view and the method to be pursued. But the student must be prepared for many objections which will be raised: by painters careless of truth, and by some scientists who will insist on divorcing science from art because they feel their own minds chained by love of minute and beautiful detail, not thinking it possible for other minds to assert their freedom; by painters too lazy to enter the field of science, and who will assert that the mission of the artist is to represent what he sees, or rather what he fancies he sees, no matter whether he sees truly or falsely; or by people who, mistaking a certain deftness of handling for a true representation of natural phenomena, will exclaim, "Surely, if such landscape-art as we have has been sufficient in the past to secure public applause, will it not suffice to retain that applause for the art of the future? or are canvases to be crowded with illustrations of botany, geology, meteorology, bryology, and a host of other 'ologies,' and then to be called landscape-art?" Such talk as this is common enough, but it is sheer nonsense. To the true artist applause is a very small matter: he will not look to the market for the measure of his success, but he will gauge the quality of his own work, whether it be true or whether it be false. The one question with him is whether his picture is to be a painting of fancies which have no existence except in the idle mind of the ignorant painter, or is it to give us a representation of facts: in short, is it to be true or is it to be a sham? No true artist will ignore scientific truth, for he knows that it is next to impossible truly to generalise a multitude of like forms when he is ignorant of the special characteristics of any one individual form of the group. He will not ignore scientific truth, for that truth is the concrete foundation of all noble, all poetical art. There is one sovereign antidote to that poison so dreaded by some timid minds, viz. the chance that rigid illustration of scientific fact will dominate the work, and the antidote lies in the *individuality* of the artist. He will clothe all truth with the poetry of his own nature—with the force of his own character. He will be humbly and faithfully dependent on science for his *knowledge* of all form, but it will be on himself that he will depend for that *expression* of it through the medium of a psychical truth which is extra-scientific, and transcends in beauty the visible form of all natural truth, of which it is at once the sublimation and the epitome.

That division of the nature-drawing classes which I purpose to call science-art, presents in its plan a fourfold object. (1) To induce youths while yet at school to take up, seriously, some branch of natural science, with a view, eventually, to original investigation, and to afford them a power, both with pencil and brush, of accurately recording the results of their observation. (2) To supply that demand which Mr. Norman Lockyer informs us is now being made by scientific men, that students in science shall be able to draw. (3) To supply intelligent and artistic draftsmen for scientific purposes and for the illustrating of scientific works. (4) Mainly and especially to engender in young men, before they leave school to enter on the business of life, a love for the pursuit of scientific truth as being amongst the keenest amusements and the truest and most enduring pleasures of life.

In the ultimate purpose of any instruction lies the test of its future usefulness to the student and to society at large. The teaching of children has in it as much the making of the history of a nation as fighting battles and making laws, and earnest teaching is amongst the grandest employments of life, provided it be noble and useful and good. The teaching which is an inducement to a proper use of time goes far to create an environment which will be beneficial to maintenance and pleasure of life mentally and morally alike, and I know of no better use of time than that of scientific inquiry, which should be encouraged in all our public schools. So with drawing. By uniting it with the pursuit of science it will cease to be subject to that derogation it at present suffers through those who regulate, both within and without, the curriculum of our schools. But here in University College School the governing body is, as is well known, liberal to a fault, and the head master takes considerable interest in this new departure in the teaching of drawing.

Time will not permit me to dwell long on the plan to be adopted in the classes for science-art. At the commencement one or more scientific subjects will be selected. In connection with these the collecting of objects will be encouraged for purposes of investigation and illustration, but collecting for the mere sake of collecting will not be countenanced. Let us take entomology as an example. The student will capture the larvæ of a *few* moths or butterflies. Of each of these larvæ he will make careful coloured illustrations from time to time, according to the results of the changes they may undergo. Faithful drawings of the plants they are fed on will be required, also of any evidences of mimicry, defensive or otherwise. Further drawings will be required of the cocoons of such of the larvæ as form them, also of the chrysalis and of the fully developed insect (together with its eggs) and of whatever mimetic peculiarities it may present. From time to time original papers will be required stating minutely the observations made while the insect is being reared. After a time the more advanced pupils will be required to pursue their investigations into its anatomical structure and functions, with the use of the microscope.

A lucid mind will guide the hand to lucid drawing—the last is, as it were, a photograph of the first. The habit of clearly defining the object in the mind will lead to clear and definite work with the pencil. To students in science the securing of this power while at school will enable such to meet the requirements of science-teachers, and will be a source of economy of time and toil. This will form a branch of the teaching in the science-art classes. Moreover it will be the foundation for realising the third object in view, viz. to supply intelligent and artistic draftsmen for scientific purposes, and for illustrating scientific works. In this branch something more—much more—will be required of the pupil than faithful and intelligent exactness of outline of form. For instance, if the boy is drawing some vegetable form, he will be required to observe, closely, not only the peculiarities of the structure, but the *habit* which is the exemplar of the mind of the plant. Further he will be shown wherein the physical beauty of the plant resides, and wherein lies that beauty which is suggestive of some psychical power which, for a purpose beyond that of mere physical form, has tinted the butterfly's wing and the corolla of flowers fertilised by humming-birds. With such instruction there is no reason why the illustrations in works on natural history should not as far transcend most modern illustrations as these transcend those in a nurseryman's catalogue.

[1] Until the student can go direct to Nature he will draw and paint, in the higher classes, from water-colour studies which have been executed entirely out of doors, and of which a large number have been kindly lent by different artists.

But the chief aim of the science-art classes will be to encourage a pursuit of scientific truth for its own sake, not for the sake of displaying talent in making beautiful drawings to be praised for them, nor for the money to be got for them when drawn, but, *simply and only, for the sake of the* TRUTH, which will yield us pure and incessant pleasure all our lives, and engender a sincere reverence for the Creator who has clothed his truths in wrappages of beautiful blossoms, and pure crystals, and opalescent clouds; in wrappages, too, which appear mean and even ugly, but they are wrappages only; even sin—that, too, is a wrappage, and looks very ugly, and is very revolting, but it covers some good, some truth which lies hid in every human heart, if we will only seek to find it.

There is a vast amount of real art-power unutilised, and so wasted, in our public schools, through narrowness of purpose in the teaching. It has been so amongst ourselves, though what we have done we have done thoroughly. We have laid a sound foundation in close observation of beautiful form and acquisition of technical power in representing it. In adding to it these nature-drawing classes, we have nothing to unteach. The field of work is simply widened that the power may be the more effectually utilised with more pleasure and with greater profit to the student, not only while at school, but as a pursuit in after life, and possibly drawing many from pleasures which are ugly, coarse, bad, and fleeting. This is a view of nature-drawing which parents might think about not without profit to their children. The pursuit of scientific truth, whether in the shape of landscape-art or of science-art, is a very noble pursuit, a very lasting pleasure; besides which science and art cannot fail to be mutually benefited, mutually advanced, in the long run, by such a conjunction as this, for indeed art loses her right hand when divorced from science, and science loses her right hand when divorced from art.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The following have been elected to the General Board of Studies:—Mr. H. M. Taylor, by the Special Board for Mathematics; Prof. Liveing, by the Special Board for Physics and Chemistry; Dr. Vines, by the Special Board for Biology and Geology.

The election to the Cavendish Professorship of Experimental Physics will take place on December 22. The endowment of the professorship is 850*l*. a year.

The provision of 100 additional microscopes for the Biology Schools has been sanctioned, and a small charge will be made to students for their use.

Mr. C. T. Heycock, of King's College, has been approved as a Teacher of Chemistry, under the regulations for medical study.

The Syndicate for obtaining plans for a Geological Museum and Chemical Laboratory has been re-appointed.

Clare College offers to give scholarships of from 40*l*. to 60*l*. for Natural Science by examination, beginning March 19 next. The subjects will be Chemistry and Chemical Physics, Botany and Geology. A fortnight's notice will be required. Candidates, who must be under nineteen on the day of examination, must also pass in Elementary Latin, Greek, and Mathematics.

It is announced that in the next Fellowship election at St. John's College (November 2, 1885) regard will be paid to candidates' original dissertations or other writings, the candidates to be prepared to be examined in the subject-matter of the same. Candidates may also be examined in special subjects chosen by themselves, provided they give full and precise information regarding such subjects not later than June 1. The performance of the candidates in the University and other examinations will be regarded.

SCIENTIFIC SERIALS

Journal de Physique, October 1884.—The constitution and origin of group B in the solar spectrum, by M. L. Thollon (one plate).—On the colour of water, by M. J. L. Soret.—The effect of the electrical state of the surface of a liquid on the maximum vapour-tension of the liquid in contact with the surface, by M. R. Blondlot (one figure).—On the measurement of the maxima and minima electromotive forces in cells with a single electrolyte, by M. Emile Reynier (two figures).—Standard cell for the measurement of electromotive forces, by M. Emile Reynier.—On the chemical theory of accumulators, by M. Emile Reynier.—On the electrolysis of solid glass, by E. Warburg.

Journal of the Russian Physico-Chemical Society (Physical Section), vol. xv., 1883.—On an air-calorimeter, by N. Hesehus.—On a differential air-calorimeter, by W. Preobragenski.—On the critical temperature of isomerides and bodies belonging to the same homologous series, by A. Nadejdine.—New application of Carnot's theorem, by B. Sresnewsky.—On an algebraic transformation and its applications to mathematical physics, by by N. Slouguinoff.—On the focal properties of diffracted rays, by M. Mertching.—On the peculiar properties of caoutchouc, by N. Hesehus.—Method of determining the mean tint of a multi-coloured surface, by Th. Petronchewsky.—On the cause and the law of the change of electrical resistance of selenium by the action of light, by N. Hesehus.—On the relation between the magnetic moment of a bundle of iron wire, its mass, and the diameter of the constituent wires, by P. Bakmetieff.—Note on organ-pipes, by P. Bakmetieff.—On some phenomena of permanent magnetism, by P. Bakmetieff.—On the luminous phenomena accompanying electrolysis, by N. Slouguinoff.—On the theory of gratings traced on curved surfaces.

Royal Academy of Belgium, Nos. 9 and 10, 1884.—Among other communications is a paper by Dr. J. MacLeod describing some interesting particulars respecting the structure and homologies of the anterior intestine of the *Arachnides*. In the *Phalangides* he has found a gland of the same nature and function as the coxal glands recently described by Prof. E. Ray Lankester as belonging to the *Limules*, the *Scorpionides*, and the *Araneides tetrapneumones*. In the *culs-de-sac*, moreover, of the male gland of the *Trombidium holosericeum*, he has found, in all the individuals examined by him, ovules situated between the mother-cellules of the spermatozoides, though there was no question there of a functional hermaphroditism.—A paper by Emile de Borchgrave gives a graphic sketch of the history of Etienne Douchan, Emperor of Servia, and the Balkan Peninsula in the fourteenth century, and of the events which led up to the battle of Kossovo, the grave of the liberty and greatness of Servia.

Cincinnati Society of Natural History.—In the October *Journal* are two papers by U. P. James: one describing four new species of fossils from the Cincinnati group, the other treating of Conodonts and fossil annelid jaws.

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, December 11.—J. W. L. Glaisher, F.R.S., President, in the chair.—The Rev. T. C. Simmons, Christ's College, Brecon, and Mr. W. J. Ibbetson, Clare College, were elected members.—Mr. Tucker read a paper on a group of circles connected with the nine-point circle considered as the locus of the intersections of orthogonal Simson lines. If PL, PM, PN are the perpendiculars from any point of the circum-circle on the sides BC, CA, AB of ABC, then LMN is a Simson line: if POP' be a diameter, then the Simson line $L'M'N'$, corresponding to P', intersects LMN at right angles in a point Q, on the nine-point circle, which is also the inscribed circle of the tricusp, enveloped by the Simson lines. These properties were stated in a paper by Steiner ("Crelle," Band liii.). In the present paper points l, m, n are taken on PL, PM, PN, such that $Ll = K.PL$, $Mm = K.PM$, $Nn = K.PN$. It was shown that the lines $l\,m\,n$, $l'\,m'\,n'$ intersect at right angles on a system of circles whose centres lie on the line connecting the circum-centre and ortho-centre (H) of ABC, that the sets of Q points (as above) lie on another straight line through H: that the circles are inscribed in tricusps, the points of contact lying on three straight lines symmetrically situated and passing through H. In the special case of nul-radius, *i.e.* when the (K) circle becomes the ortho-centre, it was seen that the images of any point on the circum-circle with regard to the three sides lie on a straight line through H.—Mr. Tucker then read parts of a paper by Mr. R. A. Roberts, entitled "Notes on the Plane Unicursal Quartic."—Two posthumous notes by the late Dr. Spottiswoode, P.R.S., were communicated, viz. on quadratic transformations, and to find whether a (certain) quadratic transformation be possible.—The Treasurer (A. B

Kempe, F.R.S.) made a short communication as to the mode of proof of the well-known theorem that, if $A\,D\,B\,E\,C\,F\,A$ be a hexagon in a plane, and if $A\,B\,C$ be collinear and $D\,E\,F$ be also collinear, then the intersections of the opposite sides of the hexagon are also collinear.—Mr. G. Heppel stated the following property of the equation to a central conic, $ax^2 + 2hxy + by^2 + c = 0$, which he had not met with in the ordinary text-books. The co-ordinates being rectangular, then, in the case of the ellipse, if $\frac{h}{c}$ be $+$ ve, the major axis passes through the first quadrant; in the case of the hyperbola, if $\frac{h}{c}$ be $-$ ve, the transverse axis passes through that quadrant. This property is proved by supposing the equation transformed to $\frac{x^2}{p^2} \pm \frac{y^2}{q^2} = 1$, and then transforming back again, so as to make the equation identical with the original equation. The comparison of coefficients gives the above law.—The President communicated a result he has obtained in elliptic functions, which will appear in a forthcoming paper.

Zoological Society, December 2.—Dr. St. George Mivart, F.R.S., Vice-President, in the chair.—Col. Biddulph exhibited a stuffed specimen of the Wild Sheep of Cyprus (*Ovis ophion*), sent for presentation to the British Museum by Sir Robert Biddulph, the High Commissioner of Cyprus.—Col. Biddulph also exhibited three heads of the Wild Sheep of Beluchistan, named *Ovis blanfordi* by Mr. Hume, and drew attention to their similarity to *Ovis cycloceros* from the Salt Range, which led him to express doubts as to the distinctness of *Ovis blanfordi* as a species.—The Secretary called the attention of the meeting to the death, on July 5 last, of the Greater Vasa Parrot (*Coracopsis vasa*), presented to the Society by the late C. Telfair, Esq., in July 1830, which had thus passed fifty-four years in the Society's Gardens, and made some observations on a peculiar habit of this species.—A communication was read from the Rev. A. M. Norman and the Rev. T. R. R. Stebbing, containing an account of the first portion of the Crustacea Isopoda dredged during the expeditions of the *Porcupine*, *Lightning*, and *Valorous*. The memoir contained descriptions of the representatives of the three families Tanaidæ, Apseudidæ, and Anthuridæ obtained during the several expeditions. A great number of new forms, chiefly from deep water, including several genera (*Sphyraphus*, *Alsotanais*, and *Tanaella* among the Tanaidæ, and *Anthelura*, *Hyssura*, *Cyathura*, and *Calathura* among the Anthuridæ), were described.—Mr. G. E. Dobson, F.R.S., exhibited a diagram designed to illustrate the evolution of the Mammalia, after Huxley.—Prof. F. Jeffrey Bell read the fifth of his series of studies in Holothuroidea. The present paper gave some further information on the characters of the Cotton-Spinner (*Holothuria nigra*).—Mr. J. Bland Sutton read a paper on the parasphenoid, the vomer, and the palato-pterygoid arcade of the vertebrated skeleton. Mr. Sutton came to the conclusion that the parasphenoid of fishes was the homologue of the vomer of mammals.—Mr. G. A. Boulenger, F.Z.S., read some notes on the edible frogs introduced into England, which he referred to two forms—*Rana esculenta typica* of France and Belgium, and *Rana esculenta lessonæ* of Italy.—A communication was read from the Count T. Salvadori containing remarks on certain species of birds from Timor Laut.—A communication was read from Mr. E. P. Ramsay, C.M.Z.S., containing the description of a supposed new species of Flycatcher from New Guinea, proposed to be called *Rhipidura fallax*.—Mr. F. Day read the third of his papers on races and hybrids among the Salmonidæ. The author gave an account of how the salmon, which had been raised in fresh water at Howietown, had been artificially spawned; and pointed out that all the hybrids between the salmon and the trouts had proved sterile, while the hybrids between the trouts and the chars had proved fertile.

Geological Society, November 19.—Prof. T. G. Bonney, F.R.S., President, in the chair.—Nicol Brown, James Charles Chaplin, Herbert W. Hughes, and Rev. Samuel Pilling were elected Fellows; Prof. A. L. O. Descloizeaux, of Paris, a Foreign Member, and Prof. Hermann Credner, of Leipzig, a Foreign Correspondent of the Society.—The following communications were read:—Note on the resemblance of the upper molar teeth of an Eocene mammal (*Neoplagiaulax*, Lemoine) to those of *Tritylodon*, by Sir Richard Owen, K.C.B., F.R.S. In this paper the author referred to the genus *Neoplagiaulax*, described by M. Lemoine from the Eocene of Rheims, as presenting premolars so like those of the Mesozoic genus *Plagiaulax* as to have suggested the above name, while the true molars in the upper jaw resembled those of South African genus *Tritylodon* even more nearly than those of *Microlestes* and *Stereognathus*, with which the latter were compared. The lower molars of *Neoplagiaulax* have only two, instead of three, longitudinal series of tubercles; and the author suggested that this may have been the case also in *Tritylodon*; and that the detached molars, on which the genus *Microlestes* is founded, may also belong to the lower jaw.—On the discovery in one of the bone-caves of Creswell Crags of a portion of the upper jaw of *Elephas primigenius*, containing, *in situ*, the first and second milk-molars (right side), by A. T. Metcalfe, F.G.S. The specimen exhibited to the Society and now described was obtained from one of the Creswell bone-caves, before the commencement of their systematic exploration by a Committee of the British Association. The bone-caves are in the Lower Magnesian Limestone of the Permian, not far from the southern limit of that deposit near Nottingham. The locality was described, and it was shown that the ravine in which the caves occur has been cut in the limestone by the little river Wollen, which probably began by excavating a cavern the whole length of the ravine. The roof of this cavern must have fallen in, and the minor lateral caverns, in which bone-deposits are found, are now similarly being converted into side ravines. The fossil was found in "Pin-Hole Cave," the most westerly on the north or Derbyshire side of the ravine, about six inches below the base of the surface-soil, here four inches deep. The cave has been described in the Society's *Journal* (vol. xxxi. p. 679), by Rev. J. M. Mello, who in 1875 obtained from this spot bones of the Arctic fox (*Canis lagopus*). As the particular mammoth teeth (first and second milk-molars of the upper jaw) occurring in the fossil were wanting in the National Collection, the author has undertaken to present the specimen to the British (Natural History) Museum.—Notes on the remains of *Elephas primigenius*, from the Creswell bone-cave, by Sir R. Owen, K.C.B., F.R.S. The author noticed the various descriptions by Cuvier and himself of milk-molars of *Elephas primigenius*, and pointed out that all hitherto known were found detached. The present is the first known occurrence of the two earliest milk-molars *in situ*. The specimen discovered by Mr. Metcalfe is a portion of the fore part of the maxilla of a very young elephant with the teeth of the right side preserved, the corresponding teeth of the left side and their sockets having been broken away. Of the two teeth thus obtained descriptions and measurements were given. The first tooth is much worn, but only the anterior portion of the second has undergone wear, the two hindmost divisions of this tooth not having risen into use. It is shown that these first teeth of *E. primigenius* differ much less from the corresponding milk-molars of the Indian elephant than the later teeth do, the thickness of the constituent enamel-plates being but little less in proportion, and the principal distinction being the greater relative breadth of the second molar, especially towards the base of the crown.—On the stratigraphical position of the Lower and Middle Jurassic *Trigoniæ* of North Oxfordshire and adjacent districts, by Edwin A. Walford, F.G.S. The author spoke of the value of the *Trigoniæ* as stratigraphical guides, and of the wealth of the Oolitic deposits of North Oxfordshire in number of species as well as of individual forms. He alluded to the recent discovery by Northampton geologists of *Trigonia literata* and *T. pulchella* in the centre of their county. By the presence of certain *Trigoniæ* as well as of corals and bored stones he endeavoured to prove the extension of a stratum at the base of the *Clypeus*-grit at Fawler, as far as Hook Norton, also in North Oxfordshire, where the bulk of the Inferior Oolite was of an altogether different type. In Mr. Walford's list were nearly thirty species and varieties from the Bajocian beds. To the lower horizons there belonged but one local form, and no species of special stratigraphical value. The presence of a few other fossils supposed to be characteristic was the only evidence of beds below the zone of *Ammonites murchisoniæ*. Series C, which appeared to be of the age of the lower *Trigonia*-grit, had yielded the greater part of the *Trigoniæ* mentioned, several of them being peculiar to the horizon, whilst others were local species. The higher beds had yielded some apparently undescribed forms, whilst hitherto unrecorded species were quoted from the Great Oolite and Forest Marble. One species (*T. lycettii*) was described as new.

Chemical Society, December 4.—Dr. Perkin, F.R.S., President, in the chair.—The following papers were read:—

On calorimetric determinations of magnesium sulphate, by S. U. Pickering. The author finds that, when the ordinary hepta-hydrated salt is heated to 100°-130°, it retains about $1\frac{1}{9}$ molecule of water. This excess of one-ninth may be expelled by heating to 150°-160°, but, if this temperature be exceeded, some anhydrous salt is formed. The numbers obtained with the monohydrated salt were 12,131 cal.; with the anhydrous salt, 20,765 cal.—On condensation compounds of benzil with ethyl alcohol, by Miss M. E. Owens and Dr. F. R. Japp. By the protracted action of very dilute alcoholic potash upon benzil in the cold, the authors have prepared in large quantity a body, $C_{30}H_{24}O_4$, fusing at 200°-201°, and crystallising from alcohol with a molecule of alcohol of crystallisation. No acetyl derivative could be prepared. A second condensation-product, $C_{46}H_{34}O_4$, fusing at 232°, was also obtained.—Note on the solubility of certain salts in fused nitrate of soda, by F. B. Guthrie. The author has experimented with the sulphates, chromates, and carbonates of barium, strontium, calcium, and lead.—On certain derivatives of isodinaphthyl, by A. Staub and Watson Smith. The authors have endeavoured, by gentle oxidation of this body, to form the corresponding naphthoic acid. Cold strong nitric acid, however, produces a tetranitro body; dilute nitric acid in sealed tubes formed phthalic acid, and permanganate gave a similar result. Chromic acid in glacial acetic acid produced isodinaphthylquinone, a yellow amorphous powder melting at 250°-260°.

EDINBURGH

Mathematical Society, December 12.—Mr. A. J. G. Barclay, President, in the chair.—Mr. P. Alexander, Lady Margaret's College, Glasgow, contributed a paper on failing cases of Fourier's theorem, remarks on which were made both by Dr. Muir, who read the paper, and by Prof. Chrystal.—Dr. Muir gave a note on a function of two integral arguments; and Mr. A. Y. Fraser discussed the number of conditions determining geometrical figures.

DUBLIN

Experimental Science Association, November 19.—On Boakes's siphons of sulphur dioxide, by Prof. E. Reynolds, F.R.S.—Photometric measurement of lighthouse illumination, by T. Syle, University student.—On photometers made of paraffin, by J. Joly, B.E. This was an arrangement based on the remarkable difference of appearance presented by a piece of cracked paraffin about the plane of the crack, if placed in an unequally illuminated field. Two similar slabs of paraffin laid together on smooth faces show this effect very well. If the illumination about the plane of contact be brought to equality, the appearance of discontinuity vanishes. The close proximity of the fields to be compared confers great sensibility on the arrangement. The effect is due to the complete dispersion of the light in the translucent paraffin, thereby causing a large amount of it to be totally reflected at the plane of contact, across which, therefore, but little of the light received on either side passes.

PARIS

Academy of Sciences, December 8.—M. Rolland, President, in the chair.—Note on the photograph of a tornado taken by J. N. Robinson Howard last August in Dakota, United States, by M. Faye.—Final researches on antiseptic intravascular coagulation, by M. L. Gosselin.—Observations of Wolf's Comet made with the 8-inch equatorial at the Observatory of Bordeaux, by M. G. Rayet.—Observations of the same comet made with the meridian circle at the same observatory, by M. G. Rayet.—On the inversion of the abelian integrals, by M. Appell.—On a trigonometric formula of interpolation deduced from two formulas already established applicable to even and odd functions respectively, by M. G. Fouret.—On a generalisation of continuous fractions, by M. H. Poincaré.—On the integrals of certain functional equations, by M. G. Kœnigs.—Note on the numerical results required for the calculations of compressed gas manometers, by M. E. H. Amagat.—On the application of Ingenhouz and de Senarmont's processes to the measurement of the relative thermic conductibilities of different substances considered as isotropic, by M. Ed. Jannettaz.—On some practical processes for examining the luminous spectra of bodies to which the method of Lecoq de Boisbaudran is inapplicable, by M. Eug. Demarçay.—On ferrocyanhydric acid and the nitroprussiates, by MM. A. Étard and G. Bémont.—On the optic inactivity of the cellulose of cotton, and on the rotatory power of the gun-cotton of photography, by M. A. Béchamp.—Chemical analysis of the so-called "*porte-graine*" beetroot in the second year of its growth, by M. H. Leplay.—On the inertia of the retinal apparatus and its variations according to the exciting colours, by M. Aug. Charpentier. From experiments made during the last few years, the author concludes that the inertia increases with the refrangibility of the stimulating rays. Hence more light is absorbed or used up in producing the luminous sensation for the blue than for the green rays, for the green than for the yellow, and so on to the red. He further shows that any increase of intensity for any given colour requires all the more light in proportion to its greater refrangibility.—On the disease of the vine known by the name of *pourridié*, by MM. G. Foex and P. Viala. This disease, which is common in the South of France, and especially in Provence and Roussillon, is attributed to a species of fungus first observed by R. Hartig, and by him named *Dematophora necatrix*.—On the presence of the middle carboniferous measures in Anjou, by M. Ed. Bureau.—The results are given of a geological survey of this district undertaken during the present year by the author and his brother, the Director of the Natural History Museum of Nantes.—Tables of atmospheric movements between the parallels of latitude 30° S. and 80° N. for November 20, 1879, and January 1, 1880, based on the barometric charts prepared by M. Léon Tisserenc de Bort, by M. Poincaré.

VIENNA

Imperial Academy of Sciences, November 13.—Researches into the intimate structure of striated muscle-fibre, by A. Rollett.—Determination of the orbit of the planet *Adria*, by E. von Hœrdtl.—Remarks on the physical constitution of the atmosphere, by N. Herz.—The botanical results of Polack's expeditions to Persia in the year 1882, by O. Stapf.—Report on the plants collected by F. Luschan in Lycia and on the Nimroud Dagh, by the same.

CONTENTS

THURSDAY, DECEMBER 25, 1884

THE "CHALLENGER" REPORTS

Report on the Scientific Results of the Voyage of H.M.S. "Challenger" during the Years 1873-76 *under the Command of Capt. George S. Nares, R.N., F.R.S., and Capt. F. T. Thomson, R.N.* Zoology—Vol. X. (Published by Order of Her Majesty's Government, 1884.)

VOLUME X. of the "*Challenger* Reports" consists of over 630 pages of text, and is illustrated by 80 plates; it contains Parts xxvi. to xxx. of the Zoological Reports, all of which have been brought out under the able management of Mr. John Murray. It speaks a great deal for the energy and speed with which the publication of these Reports is conducted, when one notes that the whole of the manuscript of this large volume was only handed in between July 1883 and July 1884, and that a portion of Dr. R. Bergh's memoir had to be translated.

The Report on the Nudibranchs is by Dr. R. Bergh. Judging from the number and variety of species of this group already described from tropical seas, it is probable that it is to the tropics we should look for the head-quarters of the group, and no doubt many and interesting species are yet to be discovered there. As few shallow-water dredgings were made during the cruise of the *Challenger*, it is not to be wondered at that the number of Nudibranchs collected was but twenty-five, including only one deep-sea form. The majority of the forms belonging to the Phylliroidæ and Æolidiadæ collected during the cruise are pelagic, and are represented by the genera Phylliroë, Glaucus, Fiona, &c.; some are littoral, such as *Janolus australis*, a single specimen of which was taken in the Arafura Sea, and one like the last referred to a new genus and species, *Cuthonella abyssicola*, was taken with the trawl in the Faroe Channel from a depth of 608 fathoms. Several new species belonging to the Tritoniadæ are described. Of the Dorididæ, two new genera and several new species are diagnosed. Of these the most interesting is *Bathydoris abyssorum*. This differs from all others of the family in the semi-globular form of the body, which is somewhat like that belonging to the genus Kalinga of Alder and Hancock, and which it also resembles in the characters of its branchia, these being composed of several separate branchial tufts, also in the development of soft conical papillæ upon the back. It has no frontal appendage, and the dorsal margin is very slightly pronounced. This new genus would appear to form a remarkable connecting link between the Tritoniadæ and the Dorididæ. The only specimen found was taken from a depth of 2425 fathoms, at Station 271, in the middle of the Pacific. Mr. Murray tells us that the body of the living animal was gelatinous and transparent, the foot was of a dark purple colour, the tentacles brown, and the gills and other external organs orange.

In an appendix, Dr. Bergh describes the only Onchidium in the *Challenger* collection as *O. melanopneumon*. Only one specimen was taken in shallow water, at Kandara, Fiji. Although some would regard the Onchidia as allied to the Nudibranchs, Dr. Bergh considers this view entirely erroneous. With regard to their phylogeny they have really nothing to do with Nudibranchs, and in a quite recent article in Gegenbaur's *Morphologisches Jahrbuch* (Band x. Heft 1, p. 172), he refutes the recent views of J. Brock. For comparison with the new species details of the anatomy of *O. tonganum* and *O. verruculatum* are given. This Report is illustrated by fourteen plates, for the most part devoted to anatomical details.

Dr. L. von Graff's Report on the Myzostomida collected during the voyage may be regarded as in some sense a continuation of his monograph on this interesting and little-known group. Of the 68 species enumerated in this Report, 52 appear as new. These Myzostomes are small disk-shaped animals, living attached to Crinoids, about whose affinities there has been up to the present a good deal of doubt, some placing them among the Worms near Tomopteris, others, as Dr. von Graff, among the Arachnids near the Tardigrades; and the discovery of a new form among the *Challenger* collection seems to confirm the correctness of this latter view. The author's class of Stelechopoda embraces the Tardigrades, Linguatulids, and Myzostomes, thus constituting a group of very lowly organised Arthropods. This Report shows that the Myzostomida do not form so uniform a group, either as to their habits or structure, as was formerly thought. It is prefaced by a very neat though brief account of the general structure of Myzostoma as far as it is known, with a graphic coloured diagrammatic representation and most minute details as to the general morphology, from which we condense the following important statements. While all the hitherto known forms were characterised by the peculiar radial arrangement of the organs of the body, several species are here described in which this arrangement is entirely lost; in some (*M. folium*) the body is greatly lengthened and the parapodia and suckers are found arranged in two parallel lines, while in a new genus (Stelechopus) not only has the external radial symmetry disappeared, but not even are the muscular septa and parapodial muscles convergent; hence, if, as the author believed long ago, the radial arrangement was an adaptation to the mechanism of fixation, or of the peculiar type of fixation, the want of it as in Stelechopus, which doubtless is a freely moving form, must be regarded as the primitive arrangement, and thus intensifies the affinity to the Tardigrades. It is interesting to find several forms entirely unprovided with suckers, though in some they may exist as mere rudimentary bodies; in one species (*M. calycotyle*) the suckers are stalked. The suggestion so aptly made by von Willemoës-Suhm that some of the Myzostomida were in all probability diœcious, has been amply verified by Dr. von Graff's researches. The two sexes when inhabiting the same cyst are at times unlike in appearance, the female being usually fifty to a hundred times as large as the male. The cyst-producing Myzostomes are of importance alike to the zoologist and the palæontologist, for these cysts have been found on the stalks of fossil Pentacrini, and as Dr. von Graff is continuing his investigations into the fossil form, he will be most grateful to any palæontologists who, having collections of fossil Crinoidea under their care, would examine the specimens and if they should notice the appearance of little pustules at the base of the pinnules, would communicate the facts to him. Of the sixty-seven species of Myzostomes

described, it must suffice to mention that elaborate illustrations are to be found of all the new ones, while Plate XVI. is altogether devoted to the illustrations of *Stelechopus hyocrini*. The body in this new type has a general similarity to a Tardigrade. Unfortunately the few specimens found being mounted in Canada balsam were somewhat altered in contour, but enough remained to surely indicate that the lateral margins of the body are nearly parallel in the middle, and become somewhat narrowed at either end. There is a conical caudal appendage. The largest specimen measured 3·5 mm. long, with a greatest diameter of ·9 mm.; the cuticle was chitinous; the parapodia, five on each side, were independent in action one of the other. The specimens were taken from species of Hyocrinus and Bathycrinus, off the Crozets, at depths of 1600 and 1375 fathoms. All the beautiful plates (sixteen in number) are from drawings by the author.

Dr. P. P. C. Hoek concludes his Report on the Cirripedia by the present series of chapters on the anatomy of the group. Unfortunately, the new forms of the deep-sea material being often represented by single specimens, it was impossible to work out their anatomy in any detail; but some excellent work has been done on forms formerly known. Thus the subject of the "complemental" males of Scalpellum is treated of, and every justice is done to the investigations of Darwin, who in 1851 first called attention to the strange phenomenon. "When we consider how much the methods of microscopical research have been improved in the thirty years which have elapsed, and that the male of *Scalpellum vulgare* which Darwin investigated is only 0·7 mm. in size, we can only wonder at the thoroughness of the information which he has given, and at the soundness of the conclusions at which he arrived." Dr. Hoek observed the complemental male in nineteen out of the forty-one new species described in the first part of the Report, but the unique specimens were not, and could not without spoiling them, be thoroughly examined. The structure of these males varies: some do not show a division of the body into a capitulum and a peduncle; a second group, while not showing either, are furnished with rudimentary valves; and a third not only have these latter but also show a distinct capitulum and peduncle. Another chapter treats of the anatomy of the complemental male in *Scalpellum ornatum*, one of the largest known. The subject of the Cypris-larvæ, of the segmental organs in the Cirripedia, of the cement apparatus, of Darwin's "true ovaria" (believed to be a pancreatic gland), the eye in Lepas, and the gynœcial organs, are also treated of and illustrated in six very beautifully executed plates from drawings by the author.

During the *Challenger* voyage human crania and skeletons were collected at several of the ports at which the ship called. These were intrusted to Prof. W. Turner for examination, and his first Report on the Human Crania forms part of the present volume. The crania were from the Admiralty Islands, the Sandwich Islands, the Chatham Islands, New Zealand, Australia, Terra del Fuego, Patagonia, and the Bush Race from South Africa. In another Report the other bones brought to England will be described. In the present Report, Prof. Turner has not restricted himself to the examination and mensuration of the skulls collected during the *Challenger's* voyage, but has, whenever possible, studied along with them skulls from the same localities, so that his Report may be looked on as an essay on the craniology of certain races of man. In all, there are described and tabulated one hundred and forty-three crania from aboriginal people who had lived in a state of uncivilisation. Not one of the skulls examined was metopic, though in a young male Australian, a Loyalty Islander, and in two New Guinea skulls traces of the frontal suture were seen in the glabella. In no skull was the malar bone either wholly or partially divided into two by a suture. In the skull of one Chatham Islander a wormian bone attained the magnitude of an intraparietal bone In a good many of the crania epipteric bones were found in the pterion on one or both sides, but Prof. Turner points out that the squamoso-frontal articulation in the region of the pterion is to be regarded as an individual peculiarity, and is not a racial character. In each group of skulls, except the Fuegian, specimens with an infra-orbital suture were met with, a suture which, though of by no means rare occurrence in the human skull, has had very little attention paid to it by anatomists. A mesial third occipital condyle was present in an Admiralty, a Sandwich, a Chatham Islander, and in a New Zealander. As several of the peculiarities noted are normal conditions in other mammals, they must be regarded when occurring in man as reversions to a lower type. It becomes of interest, therefore, to inquire if such reversions occur more frequently in savage than in civilised races. To such an inquiry Prof. Turner answers, that, while the number of skulls he reports on is certainly too limited to base any broad generalisations on as to the relative frequency of occurrence of particular variations in the different races, yet there is obviously a larger proportion of important variations to be met with among them than would occur in a corresponding number of skulls of the white race. As results of the study of the races of men described in this Report, Prof. Turner points out that in South Africa, in the southern part of South America, and in Australia, races of men exist distinguished by the small capacity of their crania, by their low intellectual development, and in the case of the Bushmen and Fuegians, by their small stature and generally feeble physical configuration. The Australians and the now extinct Tasmanians were under the average size of Europeans. In the islands to the south and east of the great Asiatic continent, the Andamanese and other Negrito tribes are distinguished by their small stature, microcephalic crania, and low state of intelligence. "It is not unlikely that these people may in the early unwritten periods of human history have had in their respective continents a much wider range of distribution than at present, and have been gradually pushed southwards into their present restricted areas by the advance of the races, more powerful in both intellectual and physical development, which we see around them. If on their displacement they failed to mix with their invaders, their physical characters would remain pure. For isolation and interbreeding carried on through many centuries would necessarily preserve and even intensify the characteristic peculiarities of each race." This Report is accompanied by an atlas of seven plates.

The concluding Report in this volume is on the Cheilostomatous Polyzoa, by George Busk, F.R.S., with thirty-six plates, of which a detailed notice, by Dr. George J. Allman, appeared in our last week's number.

GEODESY AND MEASURES OF PRECISION

A Treatise on the Adjustment of Observations, with Applications to Geodetic Work and other Measures of Precision. By T. W. Wright, B.A., C.E., late Assistant Engineer United States Lake Survey. (New York: D. Van Nostrand, 1884.)

THIS treatise will be found a valuable addition to the literature of geodetic operations; the title is, however, misleading,—it implies a discussion of the various corrections required to allow for the effects of temperature, refraction, &c.; such corrections, however, are either omitted or only superficially dealt with, and the principal subject-matter is the adjustment of unavoidable errors by the method of least squares.

The work commences by a discussion of the various causes of error, and several practical hints are given as to how to diminish them. A remark in connection with personal error is worth quoting:—"A good observer, having taken all possible precautions with the adjustments of his instruments and knowing no reason for not doing good work, will feel a certain amount of indifference towards the results obtained. The man with a theory to substantiate is rarely a good observer, unless, indeed, he regards his theory as an enemy and not as a thing to be fondled and petted."

In the second chapter the usual law of error is stated, and the method of least squares is deduced therefrom, together with formulæ for calculating the mean square error, the probable error, and the average error. The author points out that the name "probable error" is unfortunate, and so we think; he is also of opinion that the average error might with advantage be more used than it is at present as a measure of the precision of a set of observations. This chapter is concluded by a most instructive discussion on the laws of error, based on various assumptions as regards the number of sources of unavoidable error. It is first supposed that there is only one source of error, and that all errors between certain limits are equally probable; the curve of error then becomes a finite straight line. The next case considers two independent sources of error, the curve then becomes two straight lines intersecting on the axis of y at an angle of 45°. In the third case three sources of error are assumed, and the curve of error is shown to consist of three parts, which together form a close approximation to the usual curve of error. The method of least squares is further developed in the succeeding three chapters, and applied to the adjustment of the direct observations of one unknown, to indirect and to condition observations. Various methods of solving the numerous resulting equations are given, both rigorous and approximate; amongst the latter the method of solution by successive approximations as used in reducing the primary triangulation of the Ordnance Survey of Great Britain is strongly recommended. The author also recommends the use of a calculating machine, or of Crelle's Tables, in order to diminish the arithmetical labour.

The remainder of the work is devoted to applying the foregoing to triangulation, to base-line measurements, to spirit levelling, to trigonometrical levelling, to the graduation of line measures, to the calibration of thermometers, and to the discovery of empirical formulæ. The application to triangulation is treated very fully, and several methods of solving the necessary equations are given and exemplified by means of examples. One of these examples is the adjustment of the angles of a quadrilateral taken from the Survey of the Great Lakes of North America, executed by the United States engineers; three methods of solution are given, one of them being that adopted by the United States engineers.

The author remarks very truly that it is a waste of time applying the rigid methods of adjustment to tertiary or even to secondary triangulation, and he proposes a method of successive approximations by first adjusting the angles at each station for the local conditions, and then using these adjusted values for the further adjustment in connection with the side and angle equations of the net. It may be mentioned that the reduction of the secondary triangulation of Great Britain, now being carried out, is effected by a graphic method applied after the angles have been locally adjusted: this method is found to give excellent results with far less labour than even an approximate method of calculation. The criticism on the title of the work is well exemplified in the chapters on base-line measurements and on the graduation of line measurements. For instance, there is no mention of the corrections required to be made to a base-line measurement to allow for errors in alignment or of level, for the effects of temperature and for reduction to sea-level. We think that at any rate a sketch of these and other sources of error and their methods of adjustment would not have been amiss.

The adjustment of the errors of trigonometrical levelling is very fully considered, and one of the examples proposed for solution is the adjustment of the levels taken trigonometrically during the triangulation executed to determine the axis of the St. Gothard tunnel.

The following remark is, we think, worth quoting:—"Closely allied to the preceding (elimination of accidental errors) is the common idea that if we have a poor set of observations good results can be derived from them according to the method of least squares, or that if work has been coarsely done such an adjustment will bring out results of a higher grade. A seeming accuracy is obtained in this way, but it is a very misleading one. The method of least squares is no philosopher's stone; it has no power to evolve reliable results from inferior work."

An excellent feature in the work is the illustration of the text by means of examples, embracing almost every possible case that occurs in practice. Some of these examples are fully worked out, others are proposed as exercises. Most of them are derived from geodetic work carried out in the United States. In conclusion we can strongly recommend this book.

OUR BOOK SHELF

On the Higher Teaching of Agriculture. By the Rev. J. B. McClellan, M.A. (Edinburgh: T. and A. Constable, 1884.)

NOT the least among the benefits of the International Health Exhibition was the series of Conferences held in connection therewith; and of these, one of the most valuable was the Conference on Education held in August last. Dr. Armstrong's paper on science-teaching in

schools has been already noticed in NATURE (vol. xxxi. p. 19), and the paper before us, by the Principal of the Royal Agricultural College, Cirencester, is another product of the Conferences. The author looks on agriculture broadly, as extending, like the theme of the poet of the "Georgics,"

> " . . . super arvorum cultu per corumque
> Et super arboribus,"

and in a well-reasoned and well-written paper pleads for the teaching of the natural sciences, their facts, laws, methods, and applications to agriculture, to those who have the direction of agriculture in this country, or who seek fortunes in the soils of new countries. Cowley, two centuries ago, asked, "Who is there among our gentry that does not entertain a dancing-master for his children as soon as they can walk? But did ever any father provide a tutor for his son to instruct him betimes in the nature and improvements of that land which he intended to leave him?" Though this reproach is not deserved so much now as when it was written, it is still not wholly unmerited, and will so remain until those who have the possession and management of landed property shall receive some special training such as that sketched out by Mr. McClellan. This training, if fairly common, would do far more to mitigate agricultural depression than any amount of piecemeal legislation. The paper is a useful addendum to Mr. Jenkins's recent report on agricultural education, and it may be commended to the attention of landowners and others connected with agriculture.

The Text of Euclid's Geometry. Book I., uniformly and systematically arranged. With a discussion of Euclid's application of logical principles, copious notes, exercises, and a figure-book. By J. Dallin Paul, R.N. (Cambridge: Deighton, Bell, and Co., 1884.)

THIS is a "prodigious" work of 182 pages demy 8vo, printed on excellent paper, with clearly-drawn figures, devoted to the "painful" elucidation of all the difficulties to be found in the first book of Euclid's Geometry, with such other matter as hath been adumbrated in the above-cited title-page. The road may be an easy one to walk in, all stones of offence being carefully put on one side or so rearranged that the wayfarer may not stumble as he saunters along it, but it certainly is a long road. The tendency of modern agitation a few years ago was to condense our text-books with a view to get up geometry in the minimum of time, but experience has taught us that in the majority of cases junior boys are very tender-footed, and cannot be driven along the geometrical path, and so there has been a reversion to the "grand old" book with many an aid to lure the young into paths not naturally attractive to them. We do not find fault with these attempts—we have recently noticed in these columns two admirable editions of the "Elements,"—but Mr. Paul has taken, we think, an extreme course: at some perhaps not distant date, if this sort of editing is catching, we shall have a similarly got-up work devoted to Euclid's treatment of isosceles triangles with a preliminary chapter on an axiom.

Our author has had so much to do with Euclid that his views of life have possibly got to be Euclid-tinted, and he sees nothing but Euclid! It would be no wonder, for his own words are, in deprecation of the presumption of adding another edition to the many that have gone before, "having been teaching Euclid almost daily for the last twenty years to pupils who, before coming under his tuition, had learnt something of geometry from the different text-books in use during that time, he ventures to think that this experience has made manifest to him the principal advantages and disadvantages of these numerous works, and thereby enabled him to present the propositions in the form most likely to be of educational value to those who are beginning either to learn or to teach the subject." We have allowed the author to put so much in evidence that the majority of our readers may gather that this is not "just the book they wanted" for themselves, and yet may see the scope of Mr. Paul's labours.

We cannot commend the author's action in placing the notes on the propositions in the early part of the book; experience has shown him that when placed in their usual position at the end they are passed by, but their actual position here offends *our* eye, and will not, we fancy, secure the writer's object. We regret that the writer has spent so much time and thought to so little purpose, as we believe, for we cannot imagine who will be the public that will purchase his book, its size and price are a bar to its introduction into school use. We close with remarking that there is a good deal that may be of use to (say) a pupil-teacher, or to one who is not strong in geometry and yet has to teach young pupils; but much, if not all, of this, can be got in handier text-books. A good feature is the placing at the end the particular enunciations of the propositions with the diagrams placed in positions very different from those which they had in the text: this would enable a pupil to test his acquaintance with the subject. R. T.

Das kleine botanische Practicum für Anfänger. Von Dr. Eduard Strasburger. Mit 114 Holzschnitten. (Jena, 1884.)

A BOOK by Prof. Strasburger, entitled "Das botanische Practicum," has recently been reviewed in NATURE, and recognised as a most valuable addition to botanical literature. The same author has now produced a condensed edition of the same book under the heading given above. The more important of the facts distributed through the 600 pages of the first and larger edition are here collected into the smaller space of 250 pages, an arrangement which is obviously better suited to beginners. It was specially remarked in the review of the larger edition that the efficient study of the various types named would occupy the average student a longer time than the author of the book appeared to think. This smaller edition will obviate the difficulty by supplying the elementary student with a shorter course of study, while the larger book will no doubt be found more useful as a book of reference for more advanced students, or as providing a curriculum for those who will make botany their profession. The merits of good type and excellent illustrations are to be found in this smaller book in as high a degree as in the earlier and larger edition. F. O. B.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Dr. Koch and the Comma-Bacterium

THE article published in NATURE of December 4, setting forth Dr. Koch's well-known theories with regard to the connection of a comma-shaped micro-organism with cholera, serves very efficiently as the text for one who desires to point out the deficiencies in Dr. Koch's observations and reasonings on this subject. The article is the most favourable statement which can be made on the side of those who accept Dr. Koch's conclusions, and is to a certain extent not quite fair to his opponents, since his original statements are not clearly separated from the subsequent statements which he has made in reply to criticisms.

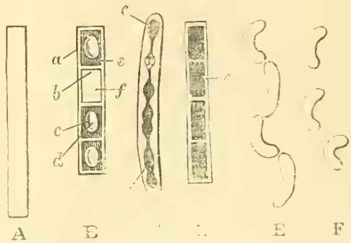
In opposing Dr. Koch's conclusions, it is desirable at the very first to state clearly that those who accept them appear to labour under two important misconceptions, the first being that Dr. Koch is, and has been for a long time, acquainted with *every* form (and the complete history of every form) of Schizomycetes or Bacteria existing, whether in the healthy body or in disease,

or in non-parasitic conditions; the second being that no one, with the exception of Dr. Koch and one or two of his pupils, has any real first-hand knowledge of Bacteria which is of any moment. It is hardly necessary to insist in the pages of a scientific journal upon the fact that these really are misconceptions. Our knowledge of the Bacteria is in its infancy—and Dr. Koch's knowledge of them is no more than that which an industrious worker may be expected to have gained in the course of very special observations in regard to a limited class of these organisms (the pathogenic class) extending over a few years. On the other hand, the study of Bacteria has been prosecuted from three separate points of view during the past fifteen years by a number of observers, who may be grouped according to their point of view as the botanists, the chemists, and the pathologists. It is undeniably the fact that neither the chemists nor the pathologists have given much heed to the work of the botanists, and that the results attained by the three groups of workers have not been brought into harmony. To the medical world the special investigations of the pathologists alone are familiar, and undue weight has been given on the one hand to generalisations which ignore the more widely-based conclusions of the botanists, and on the other hand to the introduction into the pathological arena of methods of study which are not new or original, but have been borrowed from the botanists, whose opinions are nevertheless ignored or dismissed with little consideration. As examples of these tendencies I may quote the reiterated assertion by Dr. Koch, and the pathological school, of the conclusion (upon which they base many very momentous arguments) that the forms and the activities of Bacteria are absolutely fixed and limited—that micrococci only produce micrococci, bacilli only bacilli, spirilla only spirilla, and that none of these forms vary from generation to generation, or can be produced from another of these forms, and that a micro-organism producing a particular disease or a particular ferment cannot in the course of generations lose the property of producing that disease or that ferment, and *vice versâ* that one not having such properties cannot, in the course of human experience, acquire them. This axiom of the pathologists as to fixity of form and property, is entirely opposed to the conclusions of the botanists, who reason from a much larger area of observation. Such authorities as Nägeli, Cienkowski, and de Bary are amongst those who maintain, in opposition to the pathological specialists, that wide range of form and wide range of physiological activity are possible in one species or "race" of Bacteria. To this subject I propose to revert in detail, on a subsequent occasion. As an example of the borrowing of methods by pathologists from botanists, I may quote the fact that it is customary in the writings of pathologists to attribute the gelatine method of cultivation to Dr. Koch, and to attach some additional weight to his conclusions on the ground that he has originated this and other ingenious methods of research. As a matter of fact, the gelatine method of cultivation, which is only a modification of the potato-slice method, is due to the botanist Brefeld (as acknowledged by Koch himself).

Whilst it appears that there has not been on the part of the pathologists engaged in the investigation of Bacteria such an acquaintance with, and appreciation of, the work of the botanists as would be conducive to sound conclusions, it is true that the chemists also have frequently failed in the same way. Much of the work of M. Pasteur on Bacteria is difficult, if not impossible, to verify or to use in any way, on account of the fact that he has not, in prosecuting his studies on these minute plants, made correct use of the conceptions and terminology of the botanists, and has on the other hand used that terminology erroneously and in a special sense.

Dr. Koch has given a very remarkable proof of the isolation of his knowledge and work from that of the botanists (among whom without question the most trustworthy conclusions in this department of knowledge are likely to be found) by his use of the term "spore" in his description of the tubercle-bacillus discovered by him. The "spore" of a bacillus, as shown more especially by the minute studies of the botanist Oscar Brefeld, is a very special structure formed within the filament of the bacillus by a modification of a *part* of its protoplasm, and provided with its own special capsule. Koch actually describes the whole of the constituent protoplasm of a tubercle-bacillus which has a moniliform arrangement as a series of "spores," although it is quite clear that there is nothing in common between the arrangement of the entire protoplasm of a bacillus in the form of a string of micrococci and the periodic and special elaboration of the spores of the hay and anthrax bacilli. The so-called "spores" of the tubercle-bacillus are spores only in the sense that all segments of bacteria which can be detached and multiply are spores (Arthrosporeæ of de Bary) and do not justify the distinction which Koch makes when he states that the tubercle-bacillus is characterised by producing spores, whilst stating that spirilla, such as the spirillum of relapsing fever (which breaks up into segments capable of growth), do not produce spores.

Bearing in mind these facts as to the attitude of different schools of bacteriologists, let us examine the claim put forward



A, Outline of the bacillus of glanders (which Koch says resembles the comma F). B, Diagram of *Bacillus subtilis* of hay infusion during sporulation; *a*, sheath of the bacillus; *b*, transverse septum; *c*, coat of a spore; *d*, content of a spore; *e*, protoplasm surrounding the spore, which disappears entirely when the latter is fully formed; *f*, empty or sterile segment. C, Tubercle bacillus; the protoplasm is arranged in moniliform masses (*e*), which are erroneously called "spores" by Koch. D, Diagram of hay bacillus in vegetative state; the protoplasm is arranged in block-like masses (*e*), comparable to the moniliform masses of C. E, Spirillum dividing into commas. F, Commas (stated by Koch to be identical in form with the glanders bacillus, fig. A).

by Dr. Koch, and on behalf of Dr. Koch, by the writer in NATURE of December 4, p. 97, to have discovered that a certain comma-shaped bacterium is the cause of cholera. The writer in NATURE gives a summary of the various peculiarities of growth, form, and properties which Dr. Koch states he observed to be characteristic of a micro-organism occurring in the intestine of persons dead of cholera. He then observes: "Micro-organisms presenting all these characteristics are the bacilli described by Koch; organisms presenting only some of the characteristics, such as microscopical appearance, but differing in other points, are not Koch's comma-bacilli." To this conclusion, it is quite impossible in our present state of knowledge to assent. Its acceptance by the writer of December 4 renders it improbable that he will ever be convinced that Dr. Koch has formed an erroneous conclusion. The pretension put forward on behalf of Dr. Koch amounts to this, viz., that he has ascertained all the properties of this organism, that he cannot possibly have made any mistake, and that it is more probable that this organism has, since Dr. Koch left India, disappeared from existence, and been replaced by another very much like it, but not quite the same, than that any subsequent observer should be able to correct the hurried observations made by Dr. Koch when he was there. Such a pretension, were it advanced in regard to an animal or plant belonging to a group of exceedingly well-defined and highly-organised species would be unreasonable, but when put forward in relation to a representative of a group consisting of such minute, unstable, protean, and ill-understood species as are the Bacteria, must lead us to question altogether the impartiality and critical faculty of those who make it.

Admitting, however, for a moment that Dr. Koch's comma-bacillus is as peculiar as he supposes, admitting, as Dr. Koch originally implied by his silence as to the existence of other comma-shaped bacteria, that it is utterly unlike anything at present known in shape as well as in its action on gelatine, Dr. Koch has not proved or even rendered it greatly probable that this comma-bacillus is the cause of cholera, even when we accept his statement that "he has always found the comma-bacilli constantly accompanying cholera, and that he has never found them elsewhere." In the first place, it is quite certain both from Dr. Koch's reports and from the observations of others, that cases of cholera occur in which these commas are not abundant, in fact are insignificant in quantity; and in

the second place, great as has been Dr. Koch's activity in the study of Bacteria, the fact that he and others with whom he is in relation have not found the "comma-bacilli" elsewhere does not render it at all improbable that other observers might find them elsewhere. This fallacy, viz., as to the perfection of Dr. Koch's knowledge of all possible forms and modes of occurrence of Bacteria, I have already pointed out above.

On the supposition that these comma-bacilli *never* occur except in the choleraic process it is of course impossible to maintain (see the article in NATURE of December 4, section (7), p. 98) that the choleraic process merely favours the growth of the commas. But Dr. Koch admits that they occur and flourish outside the human body, in immediate connection with cholera dejecta; also that, when artificially cultivated, they flourish on substances not derived from the human intestine. What proof is there that they do not naturally continue so to flourish? Dr. Koch offers none—he merely tells us that he has failed to show that they do. It is not at all impossible, on Dr. Koch's own showing, that they do—and if they do, what becomes of the argument as to the impossibility of their introduction from external non-choleraic conditions into the human body?

The suggestion is also considered by Koch (and is cited in the section of the article already mentioned) that, "as a result of the disease (cholera), conditions arise which cause the transformation of some ordinary bacterium into comma-bacilli." But, say Koch and his English disciple, there is no evidence of such rapid transformation of one form of bacterium into another. Here we meet with the special axiom of the pathologists to which I have already referred. The opinion of those who are entitled to the very greatest consideration, namely, the botanists Nägeli, Cienkowski, and de Bary, is that there IS evidence of such rapid transformation of one form of bacterium into another. Without going further than the case cited by the writer in NATURE as "merely" an alteration in pathogenic action, we have the instance of the attenuation of the virulence of anthrax bacilli, and we have also the case of the complete change of form of that same bacillus into nostocoid chains of spherical elements when cultivated on pork broth as shown by Klein. These two cases are by no means isolated ones (see my own researches on *Bacterium rubescens*, and also those of Zopf), but were they so they would be sufficient to establish the possibility of such changes in other Bacteria and to destroy the argument based on the assumption that such change is impossible.

The "only conclusion which remains" (see paragraph (*c*), section (7), in the article referred to) is therefore NOT that these bacilli and the cholera processes stand in the relation to each other that the commas are cause and the cholera effect. On the contrary, the only conclusion which remains is that WE DO NOT KNOW whether the commas although not detected by Koch may not be present in some parts of the healthy body, or flourishing outside it on organic matter, or may be the result of the transformation of some other bacterium, or may be the cause of cholera.

And the only way in which that ignorance can be removed has been very clearly recognised by Dr. Koch and all other recent writers, previous to the attempt made by Koch in 1884 to persuade the medical and scientific world that he had discovered the cause of cholera. The obscurity and uncertainty surrounding the Bacteria is such that no value can be attached to any asserted connection of a micro-organism with a disease as the cause of that disease, which is not based upon the experimental production of the disease by the inoculation into healthy animals of "pure cultures" of the suspected micro-organism. Dr. Koch's earlier statements on this subject are so precise and apt that I cannot do better than quote them here. He says in a pamphlet published in 1882, entitled "Ueber die Milzbrandimpfung":—

"The position which I take up is briefly as follows:—It is not yet proved that all infectious diseases are caused by parasitic micro-organisms, and consequently in each particular disease the proof of the parasitic character of the disease must be furnished. The first step towards this proof consists in the careful investigation of all those parts of the body affected by the disease, in order to establish the presence of the parasites, their distribution in the diseased organs, and their relation to the tissues of the body. . . . It is not until a thorough knowledge has been obtained in this way as to whether micro-organisms are present in the diseased parts, at what points they are present in perfect purity—whether, for instance, in the lungs, spleen, heart's blood, or elsewhere—that the attempt can be made to obtain the proof that these micro-organisms are of a pathogenic nature, and that they are more especially the cause of the disease in question. With this object in view, they must be isolated by means of 'pure cultivation,' and when they have been freed in this manner from all particles of the diseased body originally adhering to them they must be introduced by inoculation into the same species of animal in which the disease was observed, or, if that should not be possible, into animals in which the disease in question is known to occur with unmistakable symptoms. . . . An example is afforded by the disease known in man as erysipelas. It has been known for a long time that in this disease micrococci constantly are found in the lymph-vessels of the skin. *But by this knowledge it certainly was not proved that the micrococci are the cause of erysipelas.* Now, however, that Fehleisen has recently succeeded by excision of portions of skin from erysipelas patients (with every precaution against contamination by other bacteria which might be accidentally present on the skin) in rearing these micrococci in 'pure cultivations,' and in producing typical erysipelas by inoculating the human subject with these isolated micrococci, there can no longer be any doubt that the micrococci are, in fact, the cause of erysipelas, and that the latter is to be regarded as a parasitic disease."

This is the kind of proof which we require in the case of the comma-bacillus, and its supposed causal relationship to cholera. Dr. Koch has not succeeded in obtaining that proof. He has tried, and has failed, to produce cholera by inoculation of "pure cultivations" of his "comma." Cholera, at present, is not known as a disease in animals. Nevertheless, Dr. Koch has urgently and persistently declared that he considers it to be proved that the comma-bacillus is the cause of cholera! After repeated and public declarations of this conclusion, he is now making experiments by introducing his "comma-bacillus," not through the mouth, but by fistulæ into the intestine of rodents. Those who know the history of experiments on the production of cholera in mice and other rodents will not be convinced, even should Dr. Koch succeed in producing choleraic symptoms in this manner, since the readiness with which cholera-like processes are induced in these animals by abnormal conditions is such as to render them unfit subjects for these researches.

II. We may now revert to some of the statements made by Dr. Koch, which in the preceding remarks we have accepted without criticism. Even when this method is pursued, we find Dr. Koch's conclusions unwarrantable; they will appear still more so when we examine his position in detail. The writer of the article in NATURE of December 4 has omitted to notice a very important charge brought by Dr. Lewis against Dr. Koch, after the publication of Dr. Koch's address to the Medical Conference at Berlin in last August. Dr. Koch, also, has remained entirely silent in regard to this matter. It would be a very important thing if he would even now frankly reply to it. Dr. Koch and his defender assert that the "comma-bacilli" were found by Dr. Koch in cholera cases in Egypt, and also in specimens of intestine sent to him from India previous to his going there. Dr. Timothy Lewis, on the other hand, asserts that Dr. Koch had *not* recognised the "comma-bacillus" previously to his visit to India, and that in Egypt Dr. Koch attributed the causing of cholera to a totally different organism from that which he put forward after his arrival in India, and that, although he had thus shifted his ground, Dr. Koch did not admit at the time, and has not since admitted, that he was at one time convinced that cholera was caused by one organism, and a few months after was convinced that it was caused by another.

This charge is of importance for two reasons. If true, it must tend to lessen the confidence reposed by some in Dr. Koch's conclusions; and, secondly, it must also lessen our belief in the candour with which he states all the circumstances attending his observations and inferences.

The following quotations from the official reports sent home at intervals by Dr. Koch, coupled with the fact that he has not replied to Dr. Lewis on this point, though he has replied to him on other points, seems to leave little room for doubt that Dr. Lewis is perfectly correct in the very grave charge which he has brought against Dr. Koch.

In his report from Alexandria, September 17, 1883, Dr. Koch says:—"These bacteria are rod-shaped, and belong accordingly to the genus bacillus; they resemble most nearly in size and form the bacilli found in glanders" (which are straight: see woodcut, fig. A). In his report from Calcutta, dated January 9, 1884, he says:—"The microscopic examination demonstrated the presence of the same bacilli in the cholera intestine as had been found in Egypt." In a further report, dated February 2,

1884, we at last get the following remarkable statement:—"The bacilli are not quite rectilinear, like other bacilli, but slightly curved, like a comma. The curvature is sometimes sufficient to give the bacillus a semicircular form" (see woodcut, fig. F).

I think that it is abundantly clear that the organism selected by Dr. Koch in Egypt as the cause of cholera is not the same organism as that which he selected when in India, and that, although he is aware of that fact, he has not explicitly stated it, but has on the contrary (as does the writer in NATURE) endeavoured to give the impression that they are the same organism.

A further point of great importance as affecting the validity of Dr. Koch's theories, with regard to the connection of what he calls the comma-bacillus with cholera, is the statement of Dr. Lewis which is abundantly confirmed, and is not disputed by Koch, viz. that comma-bacilli, indistinguishable in appearance from those occurring in cholera cases, are quite common in the mouths of healthy persons. There is no doubt whatever that this is the case, although no record of the fact is to be found in any published treatise or paper on Bacteria, and that it was not commonly known to bacteriologists previously to Dr. Lewis' announcement of it in last September. The writer of the article in NATURE of December 4 hardly gives full effect to the importance of this point, since he cites Dr. Koch's reply to Dr. Lewis at the same time that he records Dr. Koch's earlier statements. Setting aside for the moment Dr. Koch's reply to Dr. Lewis, let us examine Dr. Koch's statements bearing on this subject, at the time when he announced his supposed discovery of the cause of cholera. He wrote from India that the organisms which he identified as the cause of cholera were of *peculiar* form, and "on account of its peculiar form, I have given to it the name of comma-bacillus." Throughout his subsequent writings, previous to the publication of Dr. Lewis's report by the Army Medical Department, Dr. Koch speaks of his cholera-organism as *the* comma-bacillus. He does not mention that any micro-organism similar to it in form is known to him. Had he been acquainted with one commonly occurring in the mouth, he would certainly have said, "The cholera comma is very like one occurring in the mouth, but differs in such and such ways." So far from this, he expressly says that no similar organism occurs in the human body, and states that he has failed to find an organism like the comma-bacillus in (amongst other places) the human mouth. No subsequent statement (after Lewis's publication) can affect the evidence which we have here that Dr. Koch was not acquainted with the "comma" which occurs in the human mouth.

After Dr. Lewis had shown that a "comma-bacillus" indistinguishable from Koch's "comma-bacillus" occurs in the healthy human mouth, and that accordingly—if we may suppose, from their identity of form and close association, that the two organisms are identical in every respect—the fundamental proposition of Koch as to the exclusive association of his comma-bacillus with cholera utterly breaks down, Dr. Koch replied as follows—(1) that the occurrence of a comma-bacillus in the mouth had long been familiar to bacteriologists (he did not say, it is to be noted, that it had long been familiar to him); and (2) that this comma-bacillus of the mouth will not grow upon neutralised cultivating-gelatine, whereas that from the intestine will, and that accordingly there is no ground for regarding them as identical species.

It seems to me in the highest degree improbable that Dr. Koch was acquainted with the mouth-comma when he published his conclusions as to the cause of cholera. If he was acquainted with it, it is undeniable that he committed a very grave fault in not drawing attention to it, and pointing out then and there the differences presented by cultures of the two commas. I have fairly conclusive evidence before me of the fact that Dr. Koch was not acquainted with the comma-bacillus of the mouth two years ago, when he published his large report and coloured plates on the tubercle-bacillus. In one of the drawings in that work he gives a delineation of the chief forms of micro-organisms occurring in the mouth, in order as he says to enable other observers to guard themselves against any confusion of the tubercle-bacillus with the micro organisms which are normally present in sputa. *No comma-like organism is figured in that drawing or mentioned by Dr. Koch.*

As to the cultures of the "comma" from cholera intestines on the one hand, and from the healthy mouth on the other, differing in respect of their properties or their sensitiveness to conditions of alkalinity and neutrality, I venture to say that, *taking into consideration the whole history of the case*, it is not sufficient for Dr. Koch to tell us in an abrupt way that such differences exist. There is no reason to accept as final and perfect Dr. Koch's account of the characters of the comma associated with cholera, and I should greatly prefer to have the comparison of the conditions of growth of the commas from these two sources made by some one who is not, as Dr. Koch must unfortunately be, so very seriously biased in one direction.

I think there is some reason to expect that we shall hear from Dr. Klein as to the result of his impartial experiments, now being carried on in Calcutta, that the comma which occurs in the healthy mouth behaves in precisely the same way under cultivation, and is in fact as in appearance the same organism as the comma which occurs in the intestines of cholera patients.

Lastly, I may record a protest against Dr. Koch's extraordinary term "comma-bacillus." I have already pointed out that Dr. Koch uses botanical terminology loosely. The word "bacillus" has been by common consent restricted to the description of such rod-like forms as Koch first associated with cholera as the result of his Egyptian work. To prefix the word "comma" to this, was perhaps a method of avoiding unpalatable explanations. At the same time it is utterly inconsistent with the sense of the words. What Koch calls "comma-bacilli" may for convenience be termed "commas." They are well known to botanists as the segments of a spirillum (see woodcut, fig. E), the result of the breaking up of a spirillum into little pieces, one corresponding to each turn of the spire. They have been clearly figured and their nature recognised by Zopf. The "commas" of the human mouth and intestine are undoubtedly related to a spirillum which is frequently found in association with them, and would not have caused any astonishment or been stigmatised as "peculiar" in form by an observer who had that adequate knowledge of the natural history of the Schizomycetes in general which Dr. Koch has in many ways shown that he does not possess.

E. RAY LANKESTER

[We desire merely to make one remark with regard to the foregoing letter. The article referred to was prepared at the request of the Editor with the view of putting before the scientific public a fair and complete statement of Dr. Koch's case. The writer of the article requests us to state that he did not, except in the last paragraph, give any views of his own, and holds himself perfectly neutral in the matter, his mind not being at all made up on the subject.—ED.]

On the Distribution of Honey-Glands in Pitchered Insectivorous Plants

THE four genera of pitchered insectivorous plants at present in general cultivation are Nepenthes, Sarracenia, Darlingtonia, and Cephalotus. Attention was drawn to the minute structure and physiological action of the first three of these by Sir J. Hooker in his celebrated presidential address to the British Association in 1874, while the structure and morphology of the last was treated of by my master, Prof. Dickson (*Journal of Botany*, 1878, 1881). Both observers pointed out an *attractive surface* studded with honey-glands, which constituted the lid part, a *conducting surface*, either of an exceedingly smooth nature (Nepenthes), or beset with small downward-directed hairs (Sarracenia, Darlingtonia, Cephalotus), and in most cases a *glandular surface* (Nepenthes, *S. purpurea*, and Cephalotus), the secretion from which directly or indirectly assisted in digestion of animal products. In Sarracenia and Darlingtonia there was found in addition a *detentive surface*, covered with long deflected hairs.

A year ago Prof. Dickson further drew attention to a set of magnificent attractive glands along the free edge of the corrugated rim in Nepenthes, which he named "marginal glands."

My attention has recently been directed to all the genera, and I propose stating here the main results. A detailed account of the comparative results obtained by examination of the different species in the young and adult condition will shortly be presented to the Royal Society of Edinburgh.

Nepenthes.—Examining a pitcher of Veitch's beautiful hybrid, *N. Mastersiana*, I observed on its outer surface what seemed to be the small openings of honey-glands. When microscopically examined, they were found exactly to resemble those on the inner lid surface, except that the gland fossa was deeply hollowed out, and opened externally by a small orifice, while its inner surface was clothed to within a short distance of the orifice

by the gland tissue, very much as in sphæriaceous fungi the cavity of the perithecium is lined by asci. But even in this they agreed with the lid glands noticed by Dickson in *N. lævis*, and termed by him "perithecioid." Careful study of the outer lid surface revealed a few similar glands. On comparison of the species and hybrids grown in the Royal Botanic Garden, Edinburgh, a like condition was found to occur in all. The presence of these on the outer pitcher surface of *N. ampullaria* is interesting, since in it the lid is rudimentary, directed back, and destitute of glands on its inner surface.

At Prof. Dickson's suggestion I then examined the expanded lamina, and was agreeably surprised to find that glands were scattered rather sparingly over its upper, but pretty abundantly over its under, surface, especially near its junction with the stem. The tendril intervening between the lamina and pitcher also possessed them, and in some cases they were of very large size. Passing to the stem, it was found that some species had them very sparingly, others in considerable number, but while resembling those on the leaf externally, they were sunk much deeper in the tissue of the cellular layer, and strikingly reminded one of a simple animal gland.

After a comparative study of the different species I was induced to look at the sepals, as our garden curator, Mr. Lindsay, had mentioned to me that a very copious secretion of nectar took place in flowering. A complete pavement of glands the same in size and appearance as those on the inner lid surface of the pitcher, was spread over the upper epidermis of each. In Hooker's elaborate monograph of the genus ("De Cand. Prod.," vol. xvii.) these are mentioned, though their complete resemblance to the latter is not indicated. A few large "peritheicoid" glands may also be seen on the lower epidermis, and in flowers of *N. bicalcarata* (for opportunity of examining which I am indebted to Mr. Courtauld of Braintree), these attain relatively a gigantic size.

We see, therefore, that in Nepenthes, with its diœcious flowers, the same structure, which by their secretion attract insects for aiding in fertilisation, also lure them to the pitcher, so that their dead bodies may help in the nutrition of the plant.

Sarracenia.—Mellichamp pointed out (*Gardener's Chronicle*, 1874) that honey-glands are present not only on the lid, but also on the external projecting wing of the pitcher. I find, however, that, as in the last genus, they are diffused over the whole outer surface, including the lid; further, that in some of the species (*S. variolaris* and *S. rubra*) there are external upward directed hairs, as in some of the Nepenthes. On the outer surface of the three bracteoles and of the sepals the glands are likewise numerous, and will undoubtedly be insect attractors for promoting cross-fertilisation.

Darlingtonia. This genus agrees with the last, except that the glands are very simple, being one- or at most two-celled. I have not as yet examined the flower, though there can be little doubt but that in it a like condition will occur.

Cephalotus.—Prof. Dickson, in studying this genus, noticed glands not only on the lid and outer pitcher surface, but even on the ordinary foliage leaves. I therefore required to deal only with the flowers. Scattered among the "encapsulating" hairs on the peduncle, bracts, and six sepals, were many glands identical with those of the leaves, though rather smaller; but further, the peculiar glandular processes intervening between the stamens and carpels seem to be the same mounted on cellular outgrowths of the receptacle.

Nepenthes, Sarracenia, Darlingtonia, and Cephalotus are therefore found to agree fundamentally in their morphological arrangements for physiological purposes, though referable to orders widely separated systematically.

J. M. MACFARLANE

Botanical Laboratory, University of Edinburgh

Earthquakes in England, and their Study

As no record of the most recent earthquake shock in England has yet found a place in the pages of NATURE, perhaps I may be permitted to give the following slight details, collected from the daily papers of Lancashire and London for November 15:—

A shock of earthquake ("severe," yet causing no actual injury) was experienced at Clitheroe, and in the neighbourhood, on the evening of November 14. At about 5.10 p.m. a terrific report, resembling loud thunder, was heard, instantly followed by a strong vibration of the earth, sufficient to induce the inhabitants to run out of their houses into the streets in a terrified state.

At Low Moor, where the shock seems to have been felt most strongly, the wife of a man named Wilkinson fainted with fright. A waggoner on the road states that his two horses were nearly thrown to the ground. Much excitement prevailed throughout the borough and neighbourhood of Clitheroe, especially at Low Moor.

A lurid glare noticed in the sky at the time of the disturbance —5.10 p.m., sun set at 4.10—is mentioned in connection with the occurrence, but that appearance was, in all probability, only one of the sunset-glow effects with which we have lately become so familiar, and had nothing to do with the shock.

The circumstance that this particular part of Lancashire is much subject to earthquake disturbances, makes it specially important that no details of their occurrence be lost to science. Within the last fifty years at least six well-authenticated shocks have been recorded,—in 1835, 1843, 1868, 1871, 1873, and 1884,—and this list might easily be extended. Lancashire, indeed, may be considered as one of the chief areas of disturbance in England, and after Comrie, in Perthshire, perhaps the most important centre of seismic action in Great Britain.

While writing upon this subject, perhaps I may be allowed to offer the suggestion that, as the study of seismology is now one of such growing importance, it would be of considerable interest to many if a small space were set apart in the columns of NATURE every month, devoted specially to the record of current earthquake action, and kindred convulsions, in a scientific manner. It is my experience, as one who has for some time been engaged in collecting certain facts of these phenomena from various sources, that no sufficiently precise and complete records of the necessary facts, as may thus be readily transferred to the annals of exact science, are anywhere available. The general observations of seismic disturbance as heretofore described, are usually not only scanty in the matter of their detail, and often dressed up still with a superstitious flavouring, but also, for lack of *the right class* of observation, are too frequently merely vague and useless statements of wrong facts, generally in favour of doubtful hypotheses; and these are allowed to take the place of a well-ordered treatment of the real state of the case, upon a proper scientific basis.

WILLIAM WHITE

55, Highbury Hill, N., December 9

The Cacao-Bug of Ceylon

THE note by Mr. Distant in your number for October 30 (p. 684) may perhaps lead its readers to think that the insect which has lately been the subject of a report to the Ceylon Government has been wrongly identified by me as *Helopeltis antonii*, Sign. As that report will, however, before this have reached England, the matter will probably have been set right. I am not an entomologist, nor have I here the opportunity of reference to Signoret's original description or to other descriptive works; but the insect is, without any doubt at all, that which is well known—too well known—in Assam and in Java as *Helopeltis*. In the former country it is the destructive tea-bug or "mosquito-blight,"[1] and in the latter it is the notorious pest of the cinchona plantations.

As to the fragments which reached Mr. Distant, they were apparently insufficient for identification, further than with the family *Reduviidæ*. The cacao-tree harbours a host of Hemiptera, and planters are very apt to confound the innocent with the guilty. Its only formidable enemy in this order of insects, however, so far as I have seen, is the *Helopeltis*.

HENRY TRIMEN

Royal Botanic Garden, Peradeniya, Ceylon, November 21

The "Messenger of Mathematics"

I THINK it is right that attention should be publicly directed to the exceedingly irregular appearance of the *Messenger of Mathematics*. In the case of a magazine of its size and character there is no reason whatever why it should not be published on the first of each month. The "heavy" mathematical journals may be permitted to turn up when their editors please; but the case of a *monthly* meant to foster a taste for mathematical investigation among junior mathematicians is entirely different; indeed, the good such a magazine is calculated to do is almost nullified by irregular publication. The *Messenger* is always

[1] Since my report was written, Mr. Wood-Mason's short treatise on the tea-bug has reached us here.

more or less irregular: just now, however, it is drawing so long a breath that one fears that its last message has been carried. We are now in the middle of December and the *October* number has not yet been heard of! ANGELUS

The Pronunciation of Chinese Names

SOMEWHAT after date, I beg to return to the subject of Anglo- and Franco-Chinese orthography, referred to in NATURE, vol. xxx. p. 592. In a short paper of mine published in the *Proceedings* of the Royal Geographical Society, vol. xxii. No. 6, 1877, I alluded to the desirability of a uniform or fixed "Roman equivalent" for Chinese characters standing for names of places, &c. I inclose a copy of this paper for insertion if desirable. To my mind the Italian vowels, &c., come nearest to the sounds of the Chinese characters. *Tung-King*, meaning "Eastern Capital," is the usually accepted form of *Tonquin*, or *Ton-Kin*, the terminal *g* being but slightly sounded. *Shang-hai*, the "Upper Sea," or the place "of going up to the sea," should be pronounced with the *g*, and is so spoken (Shanghai) by English and American authorities. Dr. Wells Williams has, I believe, in manuscript a standard Chinese Gazetteer of the World, in which all proper names likely to be used in telegraphy, newspapers, &c., are smoothly transliterated into Chinese characters. For translations from Chinese it is very necessary to adopt some such plan as Dr. Hunter has suggested for Indian names. Although his plan has come too late into the field to induce people to spell Calcutta as Kolkata, this is hardly the case as yet with Chinese names. The old native names of places should always be literally preserved. How much more beautiful is the old Franco-Indian name Stadaconda than Quebec for the scene of the death of Wolfe! I should be glad to co-operate or correspond with any interested in this matter, so prominent and important at the present juncture. F. PORTER SMITH

Hillworth House, Shepton Mallet, December 12

EXPLORATIONS IN ICELAND[1]

THE LAVA DESERT OF ÓDÁÐAHRAUN

III.

THE second part of my programme included the exploration of the western and southern portions of the Ódáðahraun Desert. In this journey I spent a fortnight during the latter half of August, a thoroughly rough and arduous time, on account of the very unsettled weather alternating between cold and rain, tempestuous gales, snowstorms, and sand-hurricanes. My journey extended to 240 English miles, but only two oases of grass were discovered the whole way. Along the skirts of Vatnajökul, throughout the whole extent of the lavas and sand plateaus which form the northern fringe or border intersecting it from Ódáðahraun, not one single blade of grass, nay, not even signs of mosses or lichens, are anywhere discoverable, hence we were obliged to provide ourselves with fodder for the horses in the shape of hay, oats, and maize dough.

The results of the journey are in every way as good as, under the circumstances, I could have anticipated. Now at last the whole of Ódáðahraun, with its surrounding wildernesses, has been explored. The weather was often enough sufficiently clear and fair to give me an opportunity to note all that required surveying The few who have travelled over various parts of these deserts before me have seen next to nothing, on account of bad weather. Ódáðahraun, as stated in a former letter, is the largest lava-desert not only in Iceland, but in all Europe; the main portion of it has been formed by volcanic activity in Iceland in prehistoric times; but since the discovery of the island, even down to our own day, the region has witnessed a succession of eruptions. The various lava flats form one plateau, the bounds of which are determined on the east by Jökulsá in Axarfjörd, south by Vatnajökul, west by Skjálfandafljót, north by Mývatn. At its southern extremity it rises to 3200, at its northern to from 1400 to 1500, feet above the level of the sea. Altogether I took there about two hundred barometric and trigonometrical elevations and surveys. The separate lava-flats are due to about twenty separate volcanoes, honeycombed by hundreds of craters. Several of the separate lavas are, to the extent of many tens of square miles, one unbroken flat lava-field as it were; others, again, all torn up and disrupted, in some cases almost, in others entirely, impassable. The substratum of Ódáðahraun is palagonite-tuff and breccia, over the top of which is spread the doleritic lava, the origin of which dates from before the Glacial period. Above all the modern lavas have flowed. All the mountains that tower above the lava consist of palagonite breccia; along their roots and spurs are frequently found rows of craters, as well as those shield-fashioned volcanoes from which the lavas have welled out. The largest volcanoes have been built up entirely by lava-floods, which have flowed successively over each other, so as to form enormous convexities presenting an equal inclination to every side, but so slight as to amount to only a few degrees. This kind of volcano, which in the north country is generally designated by the name of Dyngja, reaches in Iceland nowhere such dimensions as in Ódáðahraun, as for instance Kollótta-Dyngja, Trölladyngja, Kerlingar-Dyngja, Ketil-Dyngja. In some places many rows of craters are ranged together along rifts from north-east to south-west, as on Reykjanes, and in Dyngjufjöll, where the craters around Askja and along the slopes of the mountains are practically innumerable. In Ódáðahraun proper hardly any water is found; rain sinks through the lava, and emerges again from under its edges in many small rivers and springs. The southernmost portion of Ódáðahraun has already been buried under glacial mud and sand from Vatnajökul, incessantly poured over its edge towards the north by innumerable glacial rivulets, that mostly vanish into the underlying sands and the lavas over which they are spread. Some of the larger streams, however, find their way eastward to Jökulsá in Axarfjörd, and a few into Skjálfandafljót. In consequence of the elevation of Ódáðahraun above the level of the sea, and of its waterless condition, it is a region almost barren of vegetation. On the drift-sand a few tufts of *Elymus arenarius* or stray specimens of *Statice armeria* and *Cerastium alpinum* may be found. Round the skirts of Ódáðahraun, where the water wells forth, a good deal of vegetation shows in some places, especially along the western fringes, in the valleys of Skjálfandafljót, where summer-pastures form the sheep-walks of the inhabitants of Bárðardal. On the eastern side of Ódáðahraun there are only two oases—Herðubreiðarlindir and Hvannalindir, and here the vegetation is confined to the banks of springs, its most distinguishing feature being the *Angelica archangelica*, which grows in small clusters or bushes everywhere along the banks of the brooks. There occur likewise some species of the slighter kinds of willow, such as *Salix glauca*, *S. phyllicifolia*, *S. herbacea*, as well as a few species of heather. Over the watered shingle-flats about Herðubreiðarlindir there are spread in parts red carpets of the lovely French willow-herb (*Epilobium angustifolium*). Insect life is very poorly represented, hardly anything being visible, save a few *Diptera*. To the south of Ódáðahraun not a plot of grass is to be seen, except at Gæsavötn, in Vonarskarð, where the vegetation is of the scantiest kind, comprising indeed little more than the *Salix herbacea*. Along glacial streams no sign of vegetation is ever apparent here; what little occurs grows along fresh-water springs.

It might be imagined that such a volcanic region as Ódáðahraun would be rich in hot springs, solfataras, &c. But such is not the case. The main portion of the lava is now so old, that all such volcanic phenomena seem to have died out. Of warm springs only two may be said to be still in existence, both on the western side of the lava; yet they are only lukewarm (respectively $33\frac{1}{2}°$ and $35\frac{1}{2}°$ C.) About Gæsavötn such springs obviously once

[1] Continued from vol. xxx. p. 585.

existed, but they have now almost entirely vanished (their temperature having sunk to from 5° to 7° C). Dyngjufjöll, especially the valley of Askja, are the only localities in these regions, where volcanic manifestations of this character are now to be seen; and there hot springs, clay-pits, sulphur-mines, and fumaroles of every kind are well developed. But these appearances are to be connected with an enormous eruption which occurred as late as 1875. Throughout the whole of Ódáðahraun I have come upon no traces of subterranean heat, except at the places here mentioned. About the peninsula of Reykjanes which I explored last year, many more signs of activity were found, which seems to show that in that locality the volcanic disturbances are to be referred to a later period than those of Ódáðahraun.

The northern edge of Vatnajökul has never been examined before. In my journey I was enabled to take the various elevations of this glacier, and found that at its western extremity, in the neighbourhood of Vonarskarð, it rises to its greatest height, over 6000 feet. East of this point it becomes lower, until it rises again about Kverkfjoll, where an upheaval is perceptible right across it from north to south. From the hollow, or lowest point, the largest glacier in Iceland has taken its course. It is important that this glacier should be carefully examined, but its exploration would require a long time, for it is almost impossible to make a lengthened stay here, on account of the utter barrenness of the region, and the roughness of the weather.

In this journey I succeeded in solving the geographical riddle, which of the many rivers of Iceland is the longest. It has hitherto been assumed that Jokulsá in Axarfjörd was the longest, 100 English miles; and that next to it came Þjórsá, 96 miles long; but I have now ascertained that Þjórsá is by far the longest river in Iceland, its course being about 120 miles, while Jökulsá is only 95. Hitherto, also, it has been supposed that the sources of Jökulsá were situated in the spurs of Kistufell; they are really twenty miles further to the east, under the western slopes of Kverkfjöll. The sources of Þjórsá are situated in the north-westerly portion of Sprengisandr, to the north-west of Fjórðungsalda. Þjórsá, too, carries a greater volume of water than Jökulsá. On a July day the latter carries, midway between its source and its mouth (viz. at Grímsstaðir) 14,500 cubic feet of water per second, but Þjórsá at the proportionate point (at Þjórsárholt) carries 17,600 cubic feet in the same space of time.

Akreyri, September 7 TH. THORODDSEN

AMERICAN SUMMER ZOOLOGICAL STATIONS

IN the United States there has been during the past ten years a great increase in the advantages for the study of zoology. Not only has this increase been manifested in the colleges, but also by the facilities for summer study at the sea-shore. At present we have on the Atlantic coast five stations where there are facilities for students to carry on investigations. These laboratories are of two kinds—one where only the advanced student is allowed to study, the other in which any one manifesting a sufficient interest in Nature may be allowed a chance to work upon the marine animals; these latter are themselves divisible into two classes—one in which regular instruction is given, and the other where the student is supposed to study for himself under the direction of an efficient instructor.

The laboratory at Beaufort, North Carolina, connected with Johns Hopkins University, is intended as a place where students of the University, and somewhat advanced students from other colleges, can spend the summer in advanced work. It has attained for itself a reputation equalled by no other laboratory of its character in the country, because of the excellence of its work. Being supported by a regular fund, there are advantages connected with it which one will not find in other laboratories which are dependent upon subscriptions. Some excellent specialists spend their summers at this station, and the character of their work is shown in the bulletins published from the laboratory. Although Beaufort is not remarkably rich in variety of forms, still this is counterbalanced by the abundance of certain very interesting animals, for the study of which no better place than Beaufort can be found. As the Gulf Stream strikes on this coast, there are many interesting embryos found in the water. The building is a two storied house made to serve as a laboratory, and it is placed within a few feet of high-water mark. The location is a low sandy shore in a rather warm climate, but this is necessary on that coast where nothing else is found. For collecting purposes a steam-launch and sail-boat are used. It is under the direction of Prof. W. K. Brooks, who has done much towards making it what it now is.

Much further north, at Newport, Rhode Island, is another laboratory of a somewhat different character. It is under the charge of Prof. Alexander Agassiz, who, with a few assistants and some advanced students from Harvard College, carries on his investigations on the sea-shore. Dr. F. Walter Fewkes and C. O. Whitman study regularly at this laboratory. Because of its private character it should rather be classed with the former private laboratories which investigators were accustomed to establish at some favourite place on the sea-shore than with the general laboratories for students, though a certain limited number are admitted each summer. The advantages for study are limited, and the locality rather poor.

In the southern part of Massachusetts, at a place called Wood's Holl, the chief marine station of the United States is stationed. This is the Laboratory of the United States Fish Commission. Since 1871 the Fish Commission has each year been located at some point on the New England coast, investigating principally the specific characters of the marine fauna. Prof. Baird, the Commissioner, has had the direction of the Commission since it was first originated, and with the assistance of such eminent American naturalists as Goode, Bean, Verrill, Smith, and Sanderson Smith, the previously unkown New England fauna has been thoroughly studied, and certain parts of the North Atlantic deep sea carefully studied. For many years all the work has been done by specialists employed by Government, in a poorly adapted laboratory; but now a new building is being erected for the express purpose of serving as a laboratory, and it will be fitted up with all the modern conveniences for zoological and microscopical study. Being supported by an ample Government fund, it is expected that there will be a good library connected with it, and we know that there will be a supply of large aquaria, and that all necessary chemicals will be supplied. In addition to the tables for regular *employées*, there will be room for a limited number of students from some of the larger colleges, who will thus be offered the finest advantages for zoological study to be found in America. For the use of the laboratory there is a steam-launch, and many small boats, while the two steamers *Albatross* and *Fish Hawk* are constantly bringing in material from the deep sea and surface of the ocean. Wood's Holl is excellently adapted for the purposes of a summer laboratory, both because of climate and variety and abundance of animal forms. The work already done from the old laboratory is of world-wide renown.

This ends the list of those laboratories intended solely for advanced students. Of the other class, the Summer Institute at Cottage City, Mass., is an example. This is a summer educational institution covering a wide variety of subjects, and intended for teachers who are willing to

spend their summers in quiet study. Courses of lectures are given in various subjects, one of which is natural history, and the students can, if they choose, supplement their course by laboratory study. It is exceedingly elementary, and none but beginners attend.

Of a similar character, but of more importance, was the Summer School of Natural History at Salem, Mass., under the direction of Prof. E. S. Morse. The principle upon which this school started was wrong. The originators seemed to have the idea that courses of lectures were essential to the success of the school. Such lectures, if delivered by men of reputation, were costly, and to meet the expenses of the school a large attendance was necessary. But in America the sciences are not studied by a sufficient number of people to supply such a school, dealing in a limited branch of science, with enough students to defray the cost of lectures; and few students can afford to pay large tuition fees. So it was that the Salem School had to depend entirely upon outside aid for its continuance, and this being withdrawn, the school was obliged to break up a few years ago. It is, indeed, unfortunate that it was obliged to do this, because it was filling an important place in American scientific education by originating an interest in teachers of the public schools for this branch of study, and thus raising the standard of scientific teaching in the lower schools. If a regular fund could be placed at the disposal of some body of scientific men for the purpose of giving instruction to teachers in this way, it would be an important thing; but unless such regular support be established, other less expensive means of instruction in natural history for beginners must be looked to.

At Annisquam there is another laboratory, under the direction of Prof. Alpheus Hyatt, which has an entirely different plan for teaching beginners. At this laboratory both beginners and advanced students are allowed to study upon paying a merely nominal sum. No special instruction is given, but there is an instructor, Prof. J. B. Van Vleck, who helps the beginner over hard places in his studies. The student is given some animal to make a study of, and he is advised to examine it critically, dissect it, and make drawings of the parts, all without the aid of a book; and then, having found out all he can without aid, he is given some book to verify his observations. In this way the student goes through all the important groups of marine invertebrate animals, often learning for the first time that he can really see things for himself without the aid of books. The powers of observation are brought into play, and the first foundation of a successful student of Nature are thus laid. How much practical benefit this method of instruction will have in making original investigators cannot be told at present, because the school has been in operation for such a short time. The amount of knowledge possessed by the students at the end of the summer, compared with that with which they started, is certainly encouraging. That this is the proper method of teaching natural history has been satisfactorily demonstrated to those in charge by the results. Both sexes are admitted, and preference is given to those who are going to make use of the facts which they learn, either in teaching or in special investigation. The building is a plain one-story-and-a-half house, situated at the water's edge. It is well lighted and firm, and aquaria on each table are furnished with water from a tank filled by a windmill. For collecting purposes there are common boats, and Prof. Hyatt has a schooner yacht, in which he frequently takes parties from the laboratory upon dredging expeditions. Fifteen was the average number of students last summer, and they came from all parts of the country, being mostly teachers in small colleges and schools, and a few medical students and special investigators. In its inception it was intended for beginners, but advanced students are welcomed and given the best tables. The one unfortunate thing about this laboratory is that it is not established on a firm money basis, depending each year upon a grant of money from the Woman's Educational Society of Boston, which each year, so far, has generously given the funds for its maintenance. Neither the director nor the instructor receive salaries for their work, but furnish their summers free to the cause. For the purpose of making collections there is no better place on the eastern coast of the United States, with the exception, perhaps, of Eastport, Maine. The variety of animals is immense, and their abundance is also great, every condition necessary to an extensive fauna being present.

The last laboratory which we shall notice is the one which has long since passed out of active existence, in fact which died with its founder, the elder Agassiz. It was an immense building of wood on the island of Penikese, in Massachusetts, the outermost of the chain known as the Elizabeth Islands. The location was poorly chosen, for the fauna in the vicinity is poor, and there was no regular communication with the mainland, which was twenty miles distant. At one time during its brief existence it had a very large attendance, beginners particularly being attracted by the name of the eminent director. Lectures were given and laboratory practice was allowed each student. At this school such men as Fewkes, Faxon, Brooks, Whitman, and Alexander Agassiz, who have since become eminent in American science, received some of their first instruction in natural history. The death of Agassiz ended the institution, which if it could have been kept up under his direction would no doubt have equalled if not excelled any similar institution in the world. It is doubtful if even under Agassiz's direction this stupendous school could have been carried on, for we understand that the money basis was very insecure, and certainly the expenses were very heavy, and the tuition charges light.

RALPH S. TARR

ON A NEW METHOD FOR THE TEACHING OF SCIENCE IN PUBLIC ELEMENTARY SCHOOLS [1]

THE desirability of imparting to children some knowledge of the principles of science is now so generally agreed upon that this paper will be devoted not to the argument that science-teaching is necessary, but to a description of a method by which it may be successfully and thoroughly carried out.

In the "Code" under which the system of Government education is carried on in this country, science is mentioned under two heads:—

(1) As a "class-subject" (optional) which may be taught to any or all of the seven "Standards" under which the children are classed, and

(2) As a "specific subject" (also optional) which may only be taken by the children in Standards V., VI., and VII. The specific subjects named are—

1. Algebra.
2. Euclid and Mensuration.
3. Mechanics.
4. Latin.
5. French.
6. Animal Physiology.
7. Botany.
8. Principles of Agriculture.
9. Chemistry.
10. Sound, Light, and Heat.
11. Magnetism and Electricity.
12. Domestic Economy (*Girls*).

Either one or two (but not more than two) of these specific subjects may be taken by a child. The course in each subject is divided into three parts, so that a child must remain at school for three years in order to complete the study of any one subject.

The grants paid are at the rate of 1*s.* for a "fair" or 2*s.* for a "good" pass in class-subjects, and 4*s.* per pass in the specific subjects.

[1] By W. Jerome Harrison, F.G.S., Science Demonstrator for the Birmingham School Board. The greater portion of this article was read as a communication to the International Conference on Education, held at the Health Exhibition in July last, and is here reprinted by permission of the Executive Council.

To be successful in a public elementary school any scheme of instruction must be based upon the conditions of the Code. To these conditions, as they now stand, the following exceptions may be taken:—

(*a*) The teacher is forced to choose between geography and science as a class-subject. He may take *either*, but he cannot take *both*. As a rule he takes geography. It is to be hoped that in the future this restriction may be removed, and that a simple course of object-lessons on plants, animals, manufactures, &c., which would fulfil the requirements of science as a class-subject, will be given *in addition* to those lessons on geography which are really indispensable.

(*b*) The three years' course in a specific subject is too long, now that the child does not begin the study until it enters the Fifth Standard. Taking the case of the boys and girls presented for examination during 1883 in the Birmingham Board schools, we find in Standard V. 1864 children; in Standard VI. 482; in Standard VII. 85.

Tracing back the eighty-five Seventh Standard children, we find that they are the residue of 427 Sixth Standard children of 1882, and of 1223 who passed the Fifth Standard in 1881. It would probably be better to reduce each specific subject to a two years' course, and to allow Seventh Standard children to be examined in the work of the *two* previous years.

CHOICE OF SUBJECTS.—In considering what science

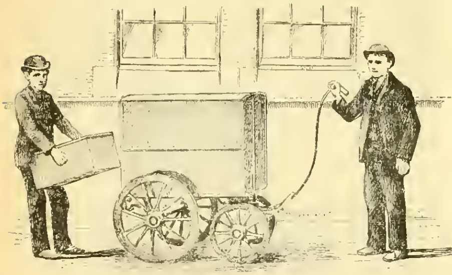


FIG. 1.—Hand-cart used for conveying apparatus from school to school.

subjects to select from those named in the Code, much will depend upon local conditions. Generally speaking, for boys' schools mechanics should be chosen, and for girls' domestic economy. As a second subject in town schools, either chemistry or magnetism and electricity may be recommended for boys, and animal physiology for girls. In country schools, principles of agriculture for boys, and botany for girls, will be found very suitable.

In the new Seventh Standard School, lately opened by the Birmingham School Board, there is an excellent workshop, fitted up with carpenters' benches, forge, lathe, &c., for forty boys. For this school I have drawn up a syllabus of a (proposed) new specific subject, entitled "Principles of Tools and Properties of Materials."

OBJECTIONS TO SCIENCE-TEACHING.—In time past three principal objections have been urged to the introduction of science-teaching into public elementary schools. These objections are:—

(1) *Want of Qualified Teachers.*—The ordinary teachers and pupil-teachers of our schools have not, as a rule, the sound knowledge of principles and practised powers of manipulation which are necessary in order to teach science with power and effect.

(2) *Want of Time.*—To *prepare* for a science-lesson, and to properly *clean and put away* the apparatus, requires more time than our closely-worked school-teachers are able to give. Some have also urged that "time" cannot be spared from the study of the "three R's," in which they consider incessant mechanical practice to be necessary.

(3) *Cost of Apparatus.*—To teach science practically—and it should be so taught to be of any value—a considerable sum must be spent in the purchase of apparatus. Thus the apparatus required for the three stages of mechanics costs about 75*l.*, and for domestic economy 65*l.*, and this is a considerable expenditure for a single school.

THE ITINERANT METHOD OF SCIENCE-TEACHING.—A method by which the principal objections urged against science-teaching in elementary schools may be overcome was suggested a few years ago by Col. Donnelly and Prof. Huxley, and it is not the least of the many services which these gentlemen have rendered to science and to education. This method has been carried out on a large scale, and with the most gratifying success by the School Boards of Birmingham and Liverpool, and the object of the present paper is to describe the manner in which the work is done in the former town.

The principal features of the itinerant method of science-teaching are as follows:—

(1) A science demonstrator is appointed, who should combine a practical knowledge of school-work and power to teach large classes with a thorough acquaintance with the branches of science which he is to teach.

(2) A "centre" is chosen in connection with some particular school, where a class-room may be set apart, or (better) a subsidiary building erected, where apparatus can be kept and the experiments prepared.

(3) A hand-cart must be provided (Fig. 1), into which the boxes containing the apparatus fit, and can so be conveyed from the science-centre to school after school by a strong youth. In this way one set of apparatus will serve for many schools. In each school department there must be a trestle-table, which should be placed in front of the class as the time for the science-lesson draws near. The hand-cart is brought to the school, the youth carries in the boxes, unpacks the apparatus, and places it upon the table. Then the science demonstrator walks in and gives the lesson. Afterwards the youth packs up the apparatus in the boxes, replaces them in the hand-cart, and marches off to the next school.

(4) A time-table is drawn up showing the exact time at which the science-lesson is given at each school, and its duration (forty-five minutes will be found suitable). A syllabus of each year's course of lessons must also be prepared (which should be distributed to the class-teachers and children), so that the subject may be gone through in a systematic way. As a rule it will be found possible for each science demonstrator to give four lessons per day, or twenty per week.

Each class should receive a lesson from the demonstrator at least once a fortnight. At each science-lesson the ordinary teacher of the class is present, and takes full notes of the matter given. During the intervening week the class-teacher *recapitulates* the science-lesson, giving such additional or new illustrations as he or she may be able to provide. The children then either write a general account of the lesson or answer three or four questions upon it, and the papers worked are submitted to the science demonstrator when he next visits the class.

It is plain that the itinerant system fairly meets the objections which have been urged against the introduction of science-teaching on the grounds of want of qualified teachers, want of time, and cost of apparatus. It also secures systematic and continuous teaching throughout the school year. The teaching is practical, and every fact or law is demonstrated experimentally. Wherever eight or ten schools are within a reasonable distance of each other, this plan may be carried into effect. Voluntary schools may combine with Board schools (as is done in Liverpool) to secure the services of a science demonstra-

tor, or small towns near to one another (as in Lancashire and Yorkshire, or in the Black Country), may unite for the same end.

APPLICATION OF THE ITINERANT SYSTEM OF SCIENCE-TEACHING IN BIRMINGHAM.—It was in June 1880 that I received my present appointment from the Birmingham School Board. Since that time the work in which I have been engaged has received the unanimous approval of the Board, but I ought especially to acknowledge the encouragement received from the Chairman—Mr. George Dixon—and from Dr. Crosskey, and the valuable advice given by the able and experienced Clerk to the Board, Mr. G. B. Davis.

Three assistants have been appointed, with a junior laboratory assistant, and two youths who work the two hand-carts which we now employ. The regular science staff thus includes seven individuals, whose salaries amount to 750*l.* per annum. In connection with the new Icknield Street School an admirable laboratory has been erected, at a cost (with fittings) of 1450*l.*, including a lecture theatre to seat eighty, a chemical laboratory and store-room, and a demonstrator's room (Fig. 2). About 400*l.* has been expended in the purchase of apparatus.

There are now thirty schools under the Birmingham School Board, attended by nearly 40,000 children.

In each of the thirty boys' departments Mechanics is taken as a specific subject by every boy in the Fifth and higher Standards; six departments take magnetism and electricity as a second specific subject.

In each of the thirty girls' departments Domestic Economy is taken as a specific subject by every girl in the Fifth and higher Standards; three departments take animal physiology as a second specific subject.

At the request of the teachers a few Fourth Standard children of exceptional ability are allowed to attend the science-lessons, since it is found not merely to do them good mentally but to induce them to remain longer at school.

The total number of children now receiving instruction in science in the Birmingham Board schools is, in round numbers:—

Mechanics	2400 boys
Magnetism and Electricity ...	300 ,,
Domestic Economy	1800 girls
Animal Physiology	100 ,,

In the framing of the syllabuses a wide interpretation has been given to these subjects; thus under the head of domestic economy as much elementary chemistry and physiology are taught as will enable an intelligent girl to comprehend the familiar facts of home life.

As a rule two science-teachers and two youths go with each hand-cart, so that the lessons to boys and girls go on simultaneously in each school. By this plan each hand-cart can visit four schools (eight departments) daily, while with a single teacher only two schools (four departments) could be visited.

The same lesson is given to class after class throughout the week. It is previously very carefully prepared by the science-demonstrator, is written out in full by him, and the experiments are tried over and the apparatus packed on Saturday morning, so that everything is ready for the start on Monday morning.

In each science subject there is but *one stage* taught in each school. Children entering on the subject join in at the second or third stage, as the case may be, so that all the children in any one department form one class, working at the same stage of the same subject. This plan simplifies the work wonderfully, and it is found in practice that the science subjects taken may be as conveniently commenced at any one of the three stages into which each is divided in the Code as at any other. Each stage stands quite by itself, and each may be considered in turn as forming an introduction to the other two.

RESULTS OF THE SCIENCE-TEACHING IN BIRMINGHAM.—The visits of the science demonstrator have been welcomed both by the teachers and children of the Board schools. The teachers have earnestly co-operated in the work, and much of its success is due to their efforts. With the children, the science-lessons have proved extremely popular. There is invariably a good attendance on the day of the science-lesson. Among the boys the half-timers then muster strongly, often getting leave to come in for that lesson only, and sitting with bare arms and rolled-up aprons, just as they have run from their work. In the same way big girls, who cannot escape from tyrannical babies, beg leave to bring their charges into the class-room; and I know of many a case where "mother" has been persuaded to change her "washing-day" because it

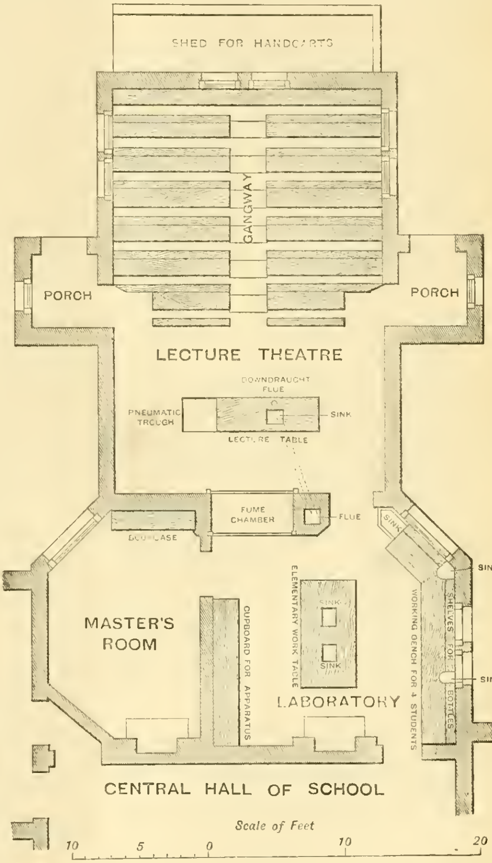


FIG. 2.

clashed with the day of the demonstrator's lesson in domestic economy. The teaching has evidently been carried home, for an irate landlord visited one school to "know what they meant by teaching children that his houses were not fit to live in!" the said houses being built "back to back," a practice the evils of which are pointed out in one of our domestic economy lessons. The large number of papers, essays, mechanical drawings, models of apparatus, &c., exhibited by the Birmingham School Board at the Health Exhibition will give some idea of the results of the work and of the eager manner in which it has been taken up by the children. So far from the science-lessons having interfered (by taking up time which would otherwise have been spent on the three R's) with the ordinary school work, the unanimous testimony of the teachers is that the increased intelligence of the children enables them to do their Standard work more easily. The idea has been very prevalent that by incessant mechanical practice excellence in the "three R's" can be secured; but the fact is that unless the intelligence be cultivated, no subject can be properly learnt. True education is culture of the mind, and mechanical acquirements have nothing in common with culture.

Applying to the matter the practical test of the Government examinations by Her Majesty's inspector, the results come out in a very satisfactory way.

Year	Number of passes in specific subjects	Percentage of passes in the three R's
1878	121	81·3
1879	424	82·0
1880 [1]	841	84·7
1881	1724	88·4
1882	3114	92·6
1883 [2]	3150	89·6

Another pleasing fact is the much larger number of children now found in the upper Standards. In 1879 (the year before the introduction of science-teaching) the percentage of children examined in Standards IV. to VII. was only 19·5; it is now 33·7.

The following extracts from the published reports of the Birmingham School Board prove that, in the estimation of those best able to judge, the teaching of science has proved a success.

1880.—"An important addition to the work of the Board schools has been the introduction of experimental lessons in elementary science. A science demonstrator has been appointed, and has now commenced work."

1881.—"In June 1881 the Board decided to appoint an assistant science demonstrator. The lessons in elementary science had proved so successful and attractive, that it was felt to be unfair that such advantages should be denied to some schools while they were afforded to others."

"These science-lessons are fully answering our expectations; the children are very attentive and much interested in the work; and, in addition to the useful knowledge they gain, their general intelligence is being developed."

1882.—"The success of the science-teaching has been strongly marked, both by the papers worked by the candidates for the science scholarships, and by the greater development of intelligence shown in regard to other subjects."

"As the teaching of science in Board schools has now become exceedingly popular, and many of the children have made considerable progress, six scholarships of 10*l.* each have been founded in connection with the Science and Art Department"

"Upwards of one thousand boys are now receiving admirable lessons in elementary science in the Board schools, and the result of this teaching is little less than marvellous."

1883.—"The teaching of elementary science in the Board schools has developed considerably during the year, the scholars taking great interest in it, and the results shown by the examinations being such as to prove that the knowledge imparted has been largely retained."

"Two great steps in advance have been made by the present Board. One is the establishment of science classes. The remarkable success which has attended these classes has been frequently alluded to, and is generally known."

Science Scholarships.—Twelve science scholarships of 10*l.* per annum have now been established in connection with the Science and Art Department. The boys who obtain these scholarships, together with an equal number selected as showing special aptitude for science, spend each Friday afternoon at the science laboratory in the study of analytical chemistry. All those hitherto examined have passed (and a large number in the first class) at the May examinations of the Department.

There are also two valuable science scholarships by which boys may pass from the Board schools to King Edward's Grammar School, and thence to the Mason Science College, their parents meanwhile receiving allowances of 15*l.* and 25*l.* per annum for their support. These scholarships are very keenly competed for, the usual number of boys examined being over 200. The examiner, Prof. Poynting, M.A., of Mason College, reports as follows:—

1882.—"Hardly any of the questions in my paper could have been answered without independent thought on the part of the candidates, and I had but very few answers showing a want of such thought. The boys showed that they had seen and understood the experiments which they described, that they had been taught to reason for themselves upon them, and that they were not merely using forms of words which they had learnt, without attaching physical ideas to them."

1883.—"The paper worked by the boy who stands highest on the list was an excellent one, and showed considerable power. The next five boys also deserve special mention as having done very good work. I think the general style of work sent in was very satisfactory. The average was not so high as last year, as the third stage of the subject was far more difficult, and the paper set was also much harder, but I think that quite as much ability was shown on the part of the candidates, and that the evidence of careful teaching was quite as strong."

Mr. Richard Tangye—the head of the great firm of Tangye and Co.—has taken a warm personal interest in the work, and his aid and countenance have been most valuable. He testifies strongly to the great improvement of his young "hands" since the introduction of the School Board system in Birmingham.

Summing up the matter, the results which we hope to obtain from this science-teaching, and which indeed have already manifested themselves, are:—

(1) The general quickening of the intellectual life of the school.

(2) The imparting of scientific knowledge and method to children which will be useful to them in after life, and which will cause many of them to continue their science-studies in evening classes.[1]

(3) The discovery of children of exceptional ability, and their support by means of scholarships.

(4) The instruction of the school-teachers in scientific principles, which they may apply to the general work of the school.

Evening Work in Science.—The work done among the teachers by means of evening science classes in connec-

[1] Science demonstrator appointed June 1880.

[2] Mundella Code introduced, by which Literature (in which 1435 passes were made in preceding year) was removed from list of specific subjects. The general requirements of this Code being higher, there was a slight drop in the percentage of passes for this year

[1] The last Report of the Birmingham and Midland Institute speaks of the influx of youths into the evening science classes—"the result doubtless of the science-teaching now carried on in the Board schools."

tion with the Science and Art Department has been of an important character. The Birmingham School Board employs about 800 teachers, and it now provides education, by means of training classes, for about 450 (the pupil-teachers and uncertificated assistants). The growth of the science work in this direction will appear from the following table:—

Year	Number of Certificates obtained	Number of First Class Certificates awarded	Gross Grant
1881	24	0	£18
1882	91	18	£108
1883	100	24	£124
1884	173	33	£197

It is very important to elementary school teachers to do well in science, since (by a regulation of the Education Department) those who have passed in science have a certain number of marks added to those which they obtain for other subjects at the Queen's Scholarship and Certificate Examinations, through which all these teachers have subsequently to pass.

Electricity and magnetism has been taught to the pupil-teachers, and physiography to the assistants.

When evening science lectures are given, however, no school-work can be done by the demonstrators in the afternoon of the same day, as the time is taken up with the preparation of the experiments, &c., for the evening lectures.

The Board possesses an excellent optical lantern presented by Messrs. R. and G. Tangye as a token of their appreciation of the science-teaching and with its assistance the science demonstrator gives popular evening science lectures in the various schools, taking subjects such as will be likely to awaken the interest and increase the intelligence of the children, as "Wild Animals in the Zoo," "The Star-lit Sky," "Two Days in London," "A Voyage to the Moon," &c. Occasionally, on fine evenings, the elder children are shown the moon, planets, double-stars, &c., through a three-inch achromatic telescope (refractor). These expositions tend to attract children to school, and to improve the regularity of the attendance.

COST OF THE SYSTEM.—The following rough balance-sheet for the year 1883-84 shows the very small cost at which the work of science-teaching is carried on in Birmingham:—

	£	s.	d.
Receipts.			
Half of Government Grant on specific subjects ...	160	0	0
Grant from Science and Art Department ...	150	0	0
	£310	0	0
Expenditure.			
Salaries ...	750	0	0
Interest on cost of buildings and apparatus ...	70	0	0
Renewal of apparatus and cost of materials ...	50	0	0
	£870	0	0

Net cost to the Board ... ... £560 per annum.

As a penny rate yields 6000*l.*, it will be seen that the cost of this system, by which more than 4000 children, distributed over sixty school departments, receive regular and practical science-lessons, amounts to only one-tenth of a penny in the pound, or to 9*l.* 10*s.* per annum for each school department. It must be remembered also that the full benefit of the system has not yet been reaped, and that the grants will certainly continue to increase. Credit has only been taken for one-half of the grant for the specific subjects.

TEXT-BOOKS.—Failing to meet with works exactly suitable for the wants of the children, the science-lessons in mechanics and in domestic economy have been written out in full, and are now published by Messrs. T. Nelson and Sons. Similar works on magnetism and electricity and on chemistry are nearly ready for issue. Each work consists of three small volumes corresponding with the three years' course prescribed by the Code. These books have already been adopted by the School Board for London, the Irish Intermediate Education Board, and other important educational bodies.

SCHOOL MUSEUMS.—For use in object-lessons, and as a constant source of pleasure and instruction, a small collection of typical objects stored in a glass-fronted cupboard ought to be placed in every school. Such cupboards are now being supplied to the Birmingham Board schools, and it has naturally fallen to the lot of the science demonstrator and his staff to assist in the mounting, naming, and classification of the objects with which the cupboards are, at little or no expense to the Board, to be filled.

CONCLUSION.—Since the commencement of this system of practical instruction in science in Birmingham, many eminent men have visited the schools to see it in operation, and they have been unanimous in their approval. In the "Instructions to Inspectors" issued by the Education Department, the system receives official sanction and commendation:—"You will often find that these (specific) subjects are most thoroughly taught when a special teacher is engaged by a group of schools to give instruction in such subjects once or twice a week, his teaching being supplemented in the intervals by the teachers of the school."

The Commissioners for Technical Education visited the Icknield Street Centre a few months ago, heard science-lessons given, and examined fully into the work. In their valuable Report, recently issued, they say:—"We could hardly overstate our appreciation of the value of the plan of giving instruction in natural science by special teachers as carried out in the Board schools of Liverpool and Birmingham, where the employment of a well-qualified science demonstrator insures the sound character of the instruction, whilst the repetition of the lesson by the schoolmaster enables him to improve himself in the methods of science-teaching."

Within the present year the work has been crowned by the opening of a Technical School for Seventh Standard boys, situated in the centre of the town, and fitted with an admirable laboratory (for forty boys), lecture-theatre, workshop (for forty, with three lathes), room for drawing, class-rooms for the ordinary subjects, and a capital dining-hall, &c. The building has been adapted, fitted (at a cost exceeding 2000*l.*), and presented rent-free to the Board by Mr. George Dixon. This school will constitute the last link of the chain of elementary education supported by the town, and who can doubt that in it will be laid the foundation of many a good work, both for the individual and the community.

NOTES

MR. J. J. THOMSON has been elected to fill the post of Cavendish Professor of Experimental Physics in the University of Cambridge in succession to Lord Rayleigh. A numerously signed requisition to Sir Wm. Thomson to become a candidate was declined.

CAMBRIDGE was *en fête* on Monday. Peterhouse, the oldest collegiate institution in the University, was celebrating the six-hundredth anniversary of its foundation. It was stated at the dinner that one-third of the present Fellows were Fellows of the Royal Society.

IT is announced that the International Sanitary Conference, which Signor Mancini proposed some time ago, will meet at Rome in February or March. Later on another Conference, also suggested by Signor Mancini, will meet to consider the possibility of some agreement for the mutual execution by the Signatory Powers of legal judgments.

The monthly weather review of the Signal Service, prepared, as announced for the first time in the August number of *Science*, by Second Lieut. W. A. Glassford, has come to be a quarto of twenty-eight pages, with five charts. This is a good growth from the four small pages and three charts of the first issue, eleven years ago. Then, the headings were storms, anti-cyclonic areas, temperature, precipitation, peculiar phenomena and facts, rivers, and cautionary signals: now, all these subjects are treated in much greater detail; and among the many additional topics there may be mentioned atmospheric pressure and its range (illustrated by a new style of chart), Atlantic storms and ice, range of temperature, frosts (illustrated by a chart for August 9 and 25), winds, local storms, tornadoes and thunderstorms, sunsets, drought, two and a half pages on the earthquake of August 10, meteors, and notes of State weather services for Alabama, Nebraska, Tennessee, Missouri, Louisiana, Ohio, and Georgia. The storm-tracks for the month are remarkably regular, and, with insignificant exceptions, all lie north of the Great Lakes and St. Lawrence: no tropical cyclones were felt along the sea-coast. Nine tornadoes are reported, and many violent thunderstorms. Some of the results of the special studies of the latter, undertaken by Mr. H. A. Hazen during the past season, take form in a brief summary, from which it appears that the mean distance and direction of the 900 thunderstorms reported in August, from the centre of the broad cyclonic storms in which they occurred, was 515 miles, a little west of south. A full account of these studies will be of much value and interest. Most of the observations on meteors are of small value, and, at best, they have but an etymological connection with a weather-review.

The completion of the Lick Observatory is stated by *Science* now to depend upon the successful making of the disk of glass for the objective of the large telescope. The main dome cannot be made till the focal length of the large equatorial has been determined.

A member of the Institute of France has brought forward a scheme for the foundation of a number of annuities, of the value of 80*l*., 160*l*., and 240*l*., to aid scientific men in the prosecution of experimental work, offering to subscribe 200*l*. towards the realisation of the scheme out of his own pocket. If the Government, who will soon have to decide on the application of Giffard's legacy of over 200,000*l*., thought fit to patronise this scheme, they have the means of giving it practical embodiment on an extensive scale.

In commemoration of the services to astronomy rendered by the French observers of the transit of Venus in 1874, the French Government have placed in the National Library of Paris a large monumental vase, designed and manufactured at Sèvres, bearing the following inscription: "La République Française à MM. Janssen, Bouquet de la Grye, André, Fleuriel, Hérault, Mouchez: Passage de Venus sur le Soleil en MDCCCLXXIV. Hommage du Gouvernement Français au Science." This vase, about 2 m. high by 1 m. broad, at present standing at the entrance of the Reading Room of the Library, will remain there for public inspection for some time, after which it will be removed to the Gallerie Mazarine, which contains a collection of rare manuscripts and other treasures.

A number of scientific men in Paris having founded a club called "La Science," for the purpose of dining together at stated times, recently entertained M. Chevreul at a banquet. The toast of the occasion was proposed by M. Jamin, the new Perpetual Secretary of the Academy of Sciences. M. Pasteur has been nominated Chairman of the next banquet. A similar club was instituted six years ago under the name of "Banquet de la Presse scientifique."

In his discourse on re-election to the Presidency of the Biological Society of Paris, M. Paul Bert stated that he had intended endeavouring to summarise the work of the Society during the preceding five years that he had held the office. But he found the task so difficult on account of the mass of facts presented by the publications of the Society, and the brevity of the papers, that he decided to abandon the idea. He promised, however, in future, at the commencement of the annual sessions, to sum up rapidly the progress realised during the preceding one. The scientific world will doubtless look forward with interest to the annual statements of the advance of biological research thus promised.

The Museum of the International Association at Brussels has just received a large collection of birds of all kinds, sent from Karema by Lieut. Storms; and also a collection made by Mr. Stanley during his last visit to the Upper Congo, consisting of utensils, furniture, musical instruments, arms, &c.

The laying of the foundation-stone of the new Sorbonne buildings will take place in a few days, the houses which covered the site intended for the new edifice having been all pulled down and the ground around the old Sorbonne to the extent of several acres having been levelled. The new buildings are to be pushed on rapidly, and the plans connected with the undertaking contemplate giving quite a new aspect to this part of the Quartier Latin. The enlargement of the Sorbonne was projected by Napoleon III. some years before 1870, and he had so far made a beginning with the work as to pull down several houses, and with all due state lay the first stone towards the additional structures in contemplation. The "first of the first stones" so laid down has been removed, though there is a rumour current that after search this first stone has not been found, and people are at a loss to know what has become of it. At all events the laying of the second of the first stones of the new Sorbonne will shortly be celebrated with becoming ceremony.

The International Society of Electricians has decided to hold an exhibition in January next, on the occasion of the first general meeting. The exhibition, which will last several days, is to be held in the rooms of the Observatory of Paris, which have been lent for the purpose by the director.

According to the *Oxford Magazine* there have been several interesting additions lately to the collection of casts in the University Museum. By the side of the skull of a Dinotherium now stands the skull of a Mastodon. Casts of the complete skeleton of Halitherium, the curious Miocene Sirenian which possesses distinct though small hind limbs, and of the hind and fore feet of the gigantic *Iguanodon Bernissartensis*, the original of which is one of the chief features of the Natural History Museum at Brussels, have also been added.

An exhibition of the arts, industries, and natural productions of the Malay Archipelago was opened under the patronage of the Government of the Dutch East Indies at Batavia last month. The productions of Penang, Singapore, North Borneo, and Sarawak are largely represented.

Prof. Mell, director of the Alabama Weather Service, announces that through the liberality of the chief signal officer and of several railways; daily weather signals predicting changes of weather and temperature, will in future be displayed at upwards of 100 telegraph stations in the State of Alabama. The predictions will be received by the director at an early hour every morning from the Signal Office at Washington, and then promptly distributed along the railways. On paying about six dollars, the cost of the signal flags, any town or telegraph station will receive free telegraphic warning of the daily weather changes. Only about five minutes are required to set the flags. A similar

extension of weather signals has been for some time in operation in Ohio and in a portion of Pennsylvania.

THE last Consular Report from China, published as a Parliamentary Blue-Book (China 6A Trade Reports), contains the appendixes to the annual report of the English Consul at Ichang. They deal with the animal, fossil, mineral, and vegetable products of the Ichang district. A considerable part of the *flora* appears to be employed only for medicinal purposes. The extracts from Mr. Gardner's diary of his travels through the province are sometimes extremely interesting; his account of a visit to the fossil quarries is especially so. Three kinds of fossils found in the district are staples of trade, the pagoda stones *Orthoceras*), kosmos stones (*Ammonites*), and the "stone swallows." The first is found in the slate, and is cut, and either framed as a picture, or made into ornamental furniture. The *Ammonites* receive the name of "kosmos stones" from their resemblance when polished to the Chinese symbol for kosmos. The so-called stone swallows are ground down, and, like much else in that region, used as medicine. These are fossil bivalves, and the name is given to them because the natives believe that they fly about underground in the same way that the swallow flies in the air. The fossil cutters appear to be a separate guild, and mostly converts to Christianity. The tools are merely a saw and a chisel. They prod about the slate until they find an *Orthoceras*, which they think will be perfect; they then cut out a slab, which they saw into two or three thin planks, so that the fossil looks like a white picture of a pagoda on a black ground. These various fossils are close together in a region at least thirty miles long, and Mr. Gardner thinks that there is hardly a cubic foot of the limey slate which does not contain a fossil or the fragment of one.

THE most recent link in the long chain of telegraph lines which is spreading with such rapidity over China is the land line from Shanghai to Canton. A line from Pekin to Tientsin was opened a few months ago, and the capital of China was connected directly with London. Now the capital of Southern China is joined with the metropolis in the north; and as Canton was put in communication by telegraph with the frontier of Tonquin at the outbreak of the present political troubles in the latter district, the telegraph now stretches in an unbroken line from Pekin in the north to the most southern boundary of the Chinese Empire, and a message either from London or Pekin might reach the head-quarters of the Chinese forces on the Tonquin frontier in a few hours. Four years ago the only telegraph line in China was one about six miles in length, stretching from Shanghai to the sea, and erected to inform the mercantile community of the arrival of vessels off the mouth of the river. The next important line constructed by the Chinese Government will probably be one uniting Pekin with the great northern lines across Siberia at Kiachta. This will have to cross the whole of Mongolia, and will give the capital of China a third alternative telegraph route to Europe, a matter to which some political importance is believed to be attached in China. As already pointed out in NATURE, this extraordinary development is due solely to political considerations.

A COMMISSION appointed by the French Government to consider the best method of developing the mineral wealth of Annam and Tonquin has just issued its report. It lays down a programme for a mining mission, which it has been decided to send out there, and suggests the appointment of two separate missions. The duty of the first of these would be to ascertain whether the metalliferous deposits stated by Annamite documents to exist in two north-western provinces of Tonquin do actually exist there, and how far it would be possible to work them profitably. The second should investigate the copper deposits of the delta, and subsequently extend its labours into Annam. A draft mining law for these regions has also been proposed. Its special provisions are those relating to the mutual rights of the owners of the soil and those who have been granted concessions to work the mines; to administrative intervention (which it is recommended should be as rare as possible) with private mine owners. The broad policy laid down by the Commission is very liberal, not only to the natives, whose rights or alleged rights are to be scrupulously respected, but also to other nations, whose subjects are, for mining purposes, to be placed on the same footing as Frenchmen. Work, it is said, can take place at once on the coal-measures known to exist on the coast of Tonquin, as well as in the adjacent islands.

THE several correspondents of *La Lumière Electrique*, who have been sent to report on the progress of electricity in America, have returned to Paris, and are preparing their reports, which will be published next year.

THE site for the Centennial French Exhibition has been selected. It is to be held on the Champ de Mars, which belongs to the War Office, but will be given up to the city of Paris. A part of the Champ de Mars will be sold for building purposes. The Central Palace of the Exhibition will be made permanent and used for yearly exhibitions like those held in London at South Kensington.

PROF. T. C. MENDENHALL, *Science* states, has been appointed Chief Electrician of the U.S. Signal Bureau.

THE additions to the Zoological Society's Gardens during the past week include a Silvery Gibbon (*Hylobates leuciscus* ♀) from Java, presented by Mr. C. H. A. Hervey; a Bonnet Monkey (*Macacus sinicus*) from India, presented by Mrs. J. N. L. Boljahn; a Common Roe (*Capreolus capræa*), British, presented by Mr. C. Hambro; a Common Rhea (*Rhea americana* ♂) from South America, presented by Lady Brassey, F.Z.S.; a Tawny Owl (*Syrnium aluco*), European, presented by Mr. W. P. Clark; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, presented by Mr. R. O. S. Ogilby; a Greater Black-backed Gull (*Larus marinus*), British, presented by Mr. T. E. Gunn; a Herring Gull (*Larus argentatus*), a Common Gull (*Larus canus*), three Greater Black-backed Gulls (*Larus marinus*), three Black-headed Gulls (*Larus ridibundus*), British, presented by Mr. W. H. Fielden, C.M.Z.S.; a Vervet Monkey (*Cercopithecus lalandii*) from South Africa, a Brush-tailed Kangaroo (*Petrogale penicillata* ♀) from New South Wales, a Hairy-fronted Muntjac (*Cervulus crinifrons* ♂), two Michie's Tufted Deer (*Elaphodus michianus* ♂ ♀) from China, a Tawny Owl (*Syrnium aluco*), European, a Hobby (*Falco subbuteo*), British, deposited; two Common Guillemots (*Lomvia troile*), a Razorbill (*Alca torda*), British, purchased.

OUR ASTRONOMICAL COLUMN

OCCULTATIONS OF ALDEBARAN.—The next series of occultations of Aldebaran visible at Greenwich commences on February 22, 1885, and terminates on October 6, 1887. The dates and mean times of immersion and emersion are as follow:—

			Immersion h. m.	Emersion h. m.
1885	February	22	5 17	5 50
	March	21	11 43	below the horizon
	November	22	9 48	10 57
1886	January	16	7 48	8 49
	April	8	5 8	5 54
	November	12	18 27	19 16
1887	January	6	12 17	13 15
	March	2	5 47	6 4
	October	6	15 20	16 2

There are therefore eight occultations in this series in which both immersion and emersion are visible, and one in which only the immersion occurs while the star is above the horizon at Greenwich. In the last series, which commenced September 28, 1866, and ended on August 2, 1869, ten occultations were wholly visible.

Occultations of Aldebaran are on record as far back as the year A.D. 491; it is stated in the Chinese Annals that the star was occulted at Nankin on March 29. Apparently the first occultation observed in Europe was found by Bullialdus in a Greek manuscript, which thus describes it:—"Anno 225 Diocletiani, Phamenoth 15 in 16, vidi Lunam sequentem claram Hyadum post accensas lucernas, digiti unius ad summam semisse. Videbatur autem occultasse ipsam. Stella quippe apposita erat parti, per quam bisecatur limbus Lunæ illuminatus." Bullialdus makes the date A.D. 509, March 11, and an approximate calculation shows that he is correct. New moon fell about 7h G.M.T. on March 6.

ENCKE'S COMET.—This comet at its present return will be observable in these latitudes in the early evening hours before perihelion. The following ephemeris is for 6h. G.M.T.:—

1885	R.A. h.	m.	s.	Decl. °	′	Log. distance from Earth	Sun
Jan. 1	22	55	26	+3	57·8	0·1526	0·1309
2	22	56	18	4	0·5		
3	22	57	12	4	3·4		
4	22	58	7	4	6·5		
5	22	59	3	4	9·8	0·1500	0·1120
6	23	0	1	4	13·3		
7	23	1	0	4	16·9		
8	23	2	0	4	20·7		
9	23	3	2	4	24·7	0·1462	0·0917
10	23	4	5	4	28·9		
11	23	5	10	4	33·2		
12	23	6	17	4	37·7		
13	23	7	25	4	42·4	0·1410	0·0699
14	23	8	35	4	47·2		
15	23	9	46	4	52·2		
16	23	10	58	4	57·3		
17	23	12	12	5	2·6	0·1344	0·0463
18	23	13	27	5	8·0		
19	23	14	44	5	13·5		
20	23	16	2	5	19·1		
21	23	17	20	5	24·8	0·1261	0·0206
22	23	18	40	5	30·7		
23	23	20	1	5	36·6		
24	23	21	24	5	42·6		
25	23	22	47	5	48·7	0·1158	9·9926
26	23	24	11	5	54·8		
27	23	25	37	6	1·0		
28	23	27	4	6	7·2		
29	23	28	31	6	13·5	0·1033	9·9619
30	23	30	0	6	19·7		
31	23	31	29	+6	25·0		

The intensity of light expressed in the usual manner is 0·27 on January 1, and 0·51 on the last date of the ephemeris.

GEOGRAPHICAL NOTES

AN interesting project was laid before the Associated Swiss Societies of Geography at their meeting at Berne last month, by M. Mullhaupt. He suggested the formation of an international geographical bureau for the following purposes:—(1) To carry out the resolutions arrived at by the International Geographical Congresses. (2) To make exchanges every month, or oftener if need be, between the eighty odd geographical societies; in place of each society sending its own publications in eighty different directions, it would only have to send them all at once to the bureau, which would do so. This, he claims, would save both time and money. (3) To publish, in the four or five principal languages, a summary of the contents of the publications of the various geographical societies; instead of each society being forced to do this for itself, a single examination would suffice to put them all *au courant* with what has been done all over the globe. There would in this way be the further advantage of knowing what was published by societies like the Geographical Society of Japan, the publications of which are in a language not generally known in Europe. M. Müllhaupt thought that the idea was not a difficult one to be carried out; the expenses would be shared by the numerous societies interested. These contain approximately 38,000 active members, and doubtless the countries having an interest in the progress of the geographical sciences would take part in a central organisation of the nature here suggested.

THE last number (Band xi. No. 8) of the *Verhandlungen der Gesellschaft für Erdkunde zu Berlin* contains two papers on West Africa: one accompanied by an excellent map, by Herr Flegel, of his recent journey along the Niger to Adamawa; the other, by Herr Reichenow, on the Cameroons, and the German colony there. Dr. Lopez writes on the Argentine States, and the importance of the German element in the foreign population there.

THE investigation of the subterranean course of the Reka River has been actively pursued for some time past by the Coast Section of the German and Austrian Alpine Society. The Reka is that mysterious river which, coming from the Schneeberg in Carniola, loses itself in the caves of the Karst, and after a subterranean course of more than thirty kilometres, breaks out of the ground near San Giovanni di Duino, is then called the Timavo, and eventually flows into the Bay of Monfalcone. Already, on March 30 last, a part of this subterranean course was investigated by a party starting from the village of St. Canzian, where a celebrated cave is situated, into which the Reka falls with thundering noise when the water is high. In September a second exploration was made. The first subterranean cave is called the Rudolfs Dome; it was from here the explorers started in two boats. First, they passed a canal about sixty metres in length, very narrow, and bounded by rocky walls one hundred metres in height; then a large cave was reached, where the party landed and fastened the boats, as waterfalls and rapids prevented further progress in boats. The underground journey was now continued on the rocky banks, the river being crossed several times on ladders. Thus six waterfalls were passed, and a seventh was reached. Altogether the explorers penetrated to a distance of between two and three hundred metres underground.

BULLETIN No. 5 of the U.S. Geological Survey is, *Science* remarks, a dictionary of altitudes in the United States, compiled by Henry Gannett, chief geographer of the Survey. It is essentially an extension of the "Lists of Elevations," prepared by the same author for Hayden's Survey; but, with the present broader organisation of the Geological Survey, the lists now appropriately include the whole country, while the earlier editions were concerned chiefly with the region west of the Mississippi. A list of authorities fills eight pages, and railroad abbreviations occupy eight more; then the States and stations follow alphabetically, the number of altitudes given being about 18,000. It is stated that the collection of railroad profiles for Pennsylvania is exceptionally complete and admirably adjusted, making the portion of the dictionary referring to that State by far the fullest and most satisfactory. By an unfortunate oversight, it is not stated whether the base level is high, mean, or low tide.

AT the recent meeting of the Ethnological Section of the Imperial Russian Geographical Society a paper was read describing Adrianow's journey through the Altai Mountains in 1881. The traveller was only able to take four companions, on account of the meagre funds at his disposal; nevertheless he was able to obtain excellent results, and to penetrate hitherto unknown regions. Although the southern slopes of the Altai Range have already been the object of investigation of various students, such as Pallas, Ledebur, Humboldt, and others, the eastern part of the region, the vast districts between the River Tom and the Government of Yenisei, have been almost a *terra incognita*. Adrianow's expedition started from the town of Kustnetsk, crossed the River Lebed, examined Lake Teletsk, touched Chulshman, Jan, and Agalan, crossed the Shapshal Pass, advanced to the River Kemchik, and sought for and found the sources of the Yenisei. They travelled through the region through which the river flows to the town of Yeniseisk, where the expedition came to an end. Throughout the journey Russians were found only around the sources of the Yenisei and on the River Usg. The population of the Altais is composed of sectaries who emigrated thither during the last century; their existence was wholly unknown until 1868, when they were by chance discovered by a Russian officer who was surveying there. Adrianow met similar colonies at Tobut on Koko-nor. These were founded in 1800. The colonists are described as savage and predatory. Besides these the traveller visited the so-called Black Tartars, on the rivers Koudoma and Luida—a tribe which has only once before been visited and described. They are regarded as descendants of the great Finnish and Turanian tribes, but hardly anything in an anthropological sense is known about them. The travellers also brought back a considerable number of pictures of monuments and works in stone, which exist among the Sajans and in Mongolia. Those of monuments to the dead are very interesting; some of them are merely

conical heaps of stones, while others are laid quite flat and are surrounded by a circle of larger stones; a third kind exhibit a primitive art of stone-cutting, the stones bearing a distant resemblance to the human body. Frequently around the graves the bones of horses which had been brought as sacrificial offerings, were found, as were also certain Runic inscriptions.

M. ADRIANOW, in his journey through the Altais, notices the existence in these regions of immigrant communities which have been forgotten and which have been re-discovered by chance. It is also reported from St. Petersburg that a similar discovery has been made elsewhere in Siberia. In the course of a prolonged inspection of his province, the Governor of Irkutsk (Governor-General of Eastern Siberia?) came across a town called Ilim, with 500 inhabitants, 150 houses, and four ancient churches, with remarkable relics of Cossack times. It is still under the republican rule of a *vetche*, or public assembly, convoked by a bell, as in old Novgorod the Great, although the new municipal institutions were supposed to have been applied to that part of the Empire ten years ago. Not one of the inhabitants can read or write.

AN important geographical work on Austro-Hungary is now being produced in parts by Mr. Alfred Hölder, the publisher, of Vienna. The author, Prof. Umlauft, gives in alphabetical order the names of the various States and peoples of the Austro-Hungarian empire, as well as those of the more important districts, mountains, rivers, and towns, with their meanings. He does not, however, confine himself simply to present names, but also gives the forms employed formerly and the various changes which the name has undergone from the earliest times down to the present day. The work is thus historical and philological. The total number of names treated will be between six and seven thousand. The first part, which has appeared, contains 1041 names, from Aa to Donau. Geographical names, it is said, not only have their history, they are themselves pieces of history. The distinction between the German and Slav names of places is characteristic. The great majority of the German village names are connected with those of persons, probably the founders or original owners, more rarely with that of the patron saint. Thus Simmering comes from Simoning, Hütteldorf from Utendorf, Hadersdorf from Hadrichsdorf, Kalksburg from Chadalhohisperg (*i.e.* mountain of one Chadalhoh), Domsdorf from Dominiksdorf. The change wrought in course of time in some names has been very great, and renders their explanation difficult. The Slav names, on the other hand, are mostly taken from the position of the place or some peculiarity in the neighbourhood. They also manifest great stability of form, and it is only in their Germanising that they have materially altered. Thus the Czech Brloh becomes in German Bierloch, Ratibor Rothwurst, and Radoina Rothweim. The Czech Lhota, which means simply a settlement which is free from taxation, assumes in German such various forms as Oehlhütten, Elhotten, Ellgoth, Wellhotten, Welhütten, Wellhütten, Mehlhüttel, Malten, and others. Even real German names have undergone the same eccentric change, and names which in their original form are quite clear in their meaning have by a slight change become incomprehensible; thus Donnersmark is really Donnerstagmarkt, or Thursday Market. It may be remembered that some articles in the *Times* during the autumn, followed by a long correspondence, did much interesting and valuable work of this kind for English place-names, though of course in a less regular and systematic form.

MR. IM THURN'S Roraima expedition left Kalacoon on October 16 with three boats and crews of seventeen Pomeroon and two Mazarooni Indians, and on the following day they ascended the first falls of the Essequibo. Simultaneously with their departure from Kalacoon, an expedition for Roraima, under the charge of a commercial botanist named Siedel, left Bartica for Roraima *via* Mazaroon. The two parties will probably meet on the mountain.

M. AYMONIER, a Saigon official, has recently returned from a journey of exploration in Indo-China. He left Saigon at the end of September last year to explore Southern Laos, and made a collection of the ancient Cambodian inscriptions. Having explored the intervening country, he reached Bangkok at the end of June last, and here he remained for some time to complete his studies on the Siamese kingdom. The result of his travels will shortly be published in the "Excursions et Reconnaissances," and he will afterwards proceed on another journey of exploration in Annam.

ROOTS[1]

IN treating of the roots of plants this evening, I may request you to dismiss from your minds any expectations or apprehensions of marvellous descriptions of tropical or rare roots on the one hand, or of a list of the peculiarities of various kinds of roots or so-called roots on the other, though it is not improbable that some of the facts will be, in part at least, new to some of you, as they certainly are to many people. I do not propose even to put any new discoveries before you. It has seemed much more to the purpose to show, as well as time will permit, that a vast amount of interesting and important information can be derived from a proper and systematic study of the roots of a common plant—information, moreover, which is important alike to the scientific botanist and to the practical agriculturist, two people who find they have more and more in common each day they come to know one another better. As the diagrams must in part have told you already, I propose that we meet on ground familiar, to a certain extent, to every one; and the sequel will show, I hope, that we have in no way acted unwisely in taking each other into confidence on the subject of an ordinary root, such as is well known to all of us. So much is this the case, that our study may be confined for the most part to the root of the common broad bean and a few other plants of our gardens.

[The lecturer then shortly described the germination of the common bean, maize, and a few other plants, and illustrated by diagrams the mode in which the first or primary root of the bean seedling emerges below, as the young seedling shoot (or "plumule") prepares to force its way upwards to the light and air. Next followed a short consideration of what this root may be said to be.] Anticipating matters to a certain extent, it may be shortly described as an organ for fixing the rest of the plant to the substratum, or soil, from which it absorbs certain food-materials. By confining our attention to this typical and well-known form of root, we may avoid any complexities resulting from the consideration of the more extraordinary cases occurring among the lower plants, or among curious aërial epiphytes, parasitic or otherwise, and other abnormal forms—forms which would demand several lectures by themselves.

The roots we have to consider, then, are organs for anchoring the rest of the plant firmly into the soil, and for absorbing certain matter dissolved in water from that soil. Obviously, we may do well to see, first, how the root gets into the soil; and secondly, how it accomplishes its objects when there.

When the young root first peeps forth from between the coats of the seed, it is seen to have its tip directed downwards towards the centre of the earth. Now this is not an accident; for if the seed be turned over, so that the apex of the root is made to turn upwards, its tip soon bends over, and again becomes directed downwards. [Mr. Ward then proceeded to explain, as shortly as could be done without detailed experimental evidence, that this persistent turning earthwards of the young root is due to a peculiar property, almost of the nature of a sensitiveness or perception to the influence of gravitation, and is not due merely to the weight of the organ.]

Next, evidence has been obtained to show that the tip of the root has a slightly rocking or swinging movement, which is more or less of the nature of the movements so well known in the case of the stems of twining plants; the tip of the root, in fact, not only moves earthwards, but tends to describe a very steep spiral as it does so. These successive very slight noddings to all sides of the tip as it proceeds in a line directed towards the centre of the earth are extremely slight, it must be borne in mind, but they may aid the point of the root to wriggle its way between the particles of earth in a loose soil, or to run down any crevice or hole it meets with.

Thirdly, in addition to its determined tendency to descend, though in a very slightly spiral course, the tip of such a root as we are describing has been found to be peculiarly sensitive to the contact of solid bodies. This extremely curious phenomenon could only be fully described by references to experiments and matters which we have scant time for. It must suffice, therefore, to state that there is evidence to show that the *extreme tip* of the root, on coming in contact with a hard resistant body, is caused to turn aside *from* that body, and if it comes simultaneously into contact with two bodies, one of which is harder than the other, it is caused to bend away from the harder of the

[1] Abstract of a lecture delivered before the Manchester Horticultural Society, in the old Town Hall, Manchester, on November 6, by H. Marshall Ward, M.A., Fellow of Christ's College, Cambridge, and Assistant Lecturer in Botany at the Owens College.

two. This property is all the more curious because, at a portion of the root a very short distance behind the tip, contact with a solid body causes that part of the root to curve *over* the touching body, much in the way that my finger is now curved over this wooden pointer. As already stated, time will not admit of our examining these very remarkable matters more closely—they form subjects for lectures in themselves.

But we have not yet finished our survey of what these sensitive tips of the roots are capable of. Experiments show that they turn towards a wet surface or atmosphere—a fact of great importance, and one which no doubt lies at the base of the explanation of the choking up of drain-pipes, &c., by the roots of neighbouring trees. Further, the apex of the root of such a plant as the bean we are considering avoids the light—avoids it as energetically as the leaves and green parts turn towards it. The two facts thus tersely put, viz. that the tip of the root tends towards a damp spot and avoids an illuminated one, are of course also in agreement with the rest of the behaviour of our germinating bean, and hence the root descends into the damp, moist, granular soil.

It is now time to see what sort of structure this wonderful root-tip possesses, and to inquire whence comes the impulse which drives it forwards into the soil—for it will be seen that while the forces producing the various curvatures which have been referred to tend to guide the apex of the root downwards between the particles of soil, towards the darker, moister, deeper parts, they cannot be expected to drive it into the soil.

In the first place, the tip is a firm, conical, smooth body, covered with a slippery, loose root-cap, as seen in the diagrams. Now, it cannot be too carefully borne in mind that the true tip of the root, beneath the covering cap, is resistant and somewhat elastic; it consists of multitudes of minute tightly-packed cells, each densely filled with protoplasmic substance containing very little water, and of a consistency resembling in some degree that of a well-made, hard-set jelly. Perhaps, indeed, a better idea of it may be gained if the conical tip of the root is compared to a firm, resistant jelly, cut up by delicate partitions into multitudes of minute blocks, which, however, are not separated from one another at all. In any case, it is clear that such a cone, if steadily and slowly driven by a persistent force from behind, is admirably adapted for penetrating between the particles of soil, especially if we bear in mind the following facts: (1) the cone is protected by a slippery cap of loose cells, which prevents the abrasions of the particles of soil from injuring the cells beneath; (2) the driving force is steady and continuous, and directed vertically, *i.e.* along the axis of the cone; (3) the tip oscillates slightly from side to side, and is thus probably (though not to any very great extent) insinuated between the earthy particles, no doubt being aided to a certain extent by other properties to which allusion has been made. It is of course obvious that the last thing we should expect of such a cone is that it could take up quantities of water from the soil: its structure is clearly in no way adapted for such a purpose, if only from the fact that there would be nowhere for the water to effect an entrance.

And now comes the question, What is this steady, continuous driving force from behind? Well, it is due to the simultaneous elongation of the hundreds of thousands of little cells situated a short distance behind the more rigid cone we have just examined. No doubt it seems a hard fact to grasp—that the absorption of water, and the intercalation of minute particles of substance in the interior of the cells shown in this diagram should be capable of steadily driving the apex of the root into the soil; but it is a fact nevertheless. Perhaps you will apprehend the matter more clearly if I offer you a well-known illustration which, it is true, does not exactly cover all the facts, but which will, at any rate, aid you in overcoming some initial difficulties. You are well aware that a wedge of wood driven firmly into a crack in a rock and then moistened, swells, and that it may swell so powerfully as to fracture the rock; very well, the elongation of the cells behind, which steadily drives the firm cone of the root forwards, is to a great extent due to the absorption of water, which causes each cell to grow longer. I say to a great extent, because, while the water is, on the one hand, absorbed in a slightly different way and enlarges the volume of each cell to a much greater extent, there are, on the other hand, forces at work which cause new particles of substance to be added to those originally composing the cells, and so fix the cells, as it were, in their condition of greater elongation, strengthening them at the same time. But this is not all. Besides growing longer, and thus driving the apex steadily forwards, the cells behind increase in diameter, and so push aside the particles of the soil with a force which would astonish you if I entered into figures; this, however, can only be adverted to here, since we must now pass to the explanation of one or two other points.

It is clear that, great as is the driving force supplied by so many elongating cells—and, of course, it is upon the simultaneous action of countless thousands of cells that the driving power depends—it would soon cease to be of much use unless a holdfast were insured at some point behind. This brings me to the consideration of an extremely important matter, and one on which I hope to make you quite clear. At first, while the root is still very young (as in this diagram), the weight of the seed above, with that of any soil covering it, seems to suffice to afford the necessary points of application; and this will doubtless be supplemented immediately afterwards by the increase in diameter of the upper part of the root.

When the root has attained some little length, however, a striking change takes place in its behaviour to the surrounding soil. First, let me call your attention to the following points, as illustrated by these diagrams. When the young primary root has attained a length of about four to six or eight inches—depending on circumstances which we need not occupy time in examining—the older portion nearest the seed has ceased to grow in length, and its surface is becoming clothed with a dense covering of very delicate hairs, which will be referred to in future as the "root-hairs." Each root-hair is an extremely slender sac—a sort of long tubular bladder, in fact—which possesses in virtue of its peculiar organisation an extraordinary aptitude for taking up water, and for attaching itself to the particles of soil with which it comes in contact. These facts are well illustrated by reference to these diagrams, to which I wish your attention for a few minutes.

From the delicacy of these root-hairs, and from their springing at right angles from the surface of this part of the root, radiating in all directions between the particles of soil, to which they immediately proceed to glue themselves, it is obvious that they are saved from being torn away as the tip of the root is slowly driven forwards between the particles of soil; if they were to arise on the tip itself, or on the parts which are elongating behind it, they would infallibly be removed by the abrasion of the particles of soil. Instead of this, however, they become developed on the parts behind in successive multitudes as those parts cease to elongate.

At the same time, the thousands of points of attachment established by the root-hairs afford the holdfast which becomes more and more necessary as the apex of the root is driven further and further forwards, and as the weight of the aërial parts of the plant, with their increasing surfaces exposed to wind and weather, become larger.

Meanwhile, leaving aside for the moment the consideration of how these millions of root-hairs take up the water and food-matters from the soil, the young root has been making preparations for obtaining a still firmer and wider holdfast on the soil, which will, at the same time, enable them to absorb water and food-materials at millions of new points further and further removed from the centre at which the primary root commenced its operations. To understand this, I must call your attention to this diagram, showing how the branching of the root proper is brought about. In the interior of the growing root a number of cells begin to multiply at certain points, and to form the young beginnings of lateral roots or rootlets; further back you see these young lateral roots upheaving the tissues of their parent root as minute knobs. By this time, however, these portions of the mother root have ceased to grow in length, and thus the tender little tips of the lateral roots can protrude and be pushed into the soil around without danger of being dragged off or injured, as they would inevitably be if this part of their mother root were still actively elongating. Notice carefully the exquisite adaptation to the circumstances, though brought about in a slightly different manner; no time is lost in the preparation of the young root branches within the tissues of the parent root, but the tender tips, as in the case of the root-hairs, only proceed to grow radially into the surrounding soil when the growth of the mother root in a direction across their long axes has ceased.

Time will not allow of our examining these matters more in detail; but I cannot avoid calling your attention to the fact that these lateral roots are sensitive to gravitation in a manner different from the primary root—they grow, not straight down towards the centre of the earth, but across the vertical, it may be more or less inclined, in different cases. In other respects they

resemble the primary root generally, in their turn producing root-hairs and daughter roots, which radiate from them in all directions into new portions of the soil, as shown in this diagram.

I need not do more than point out to you that it would be difficult to conceive of a series of adaptations better calculated to insure that the various parts of the root-system come successively in contact with the whole mass of soil traversed; and when your eyes follow mine over this diagram, you will agree that matters have become so arranged, so to speak, between the roots and the soil, that every part of the latter is laid under contribution. Notice how this vertical cylinder of earth is first bored through by the primary root, and then traversed in all directions by the root-hairs, in a wave, as it were, passing from above downwards. Next come the lateral roots, burrowing in all directions from the main shaft, and each in turn demanding toll from the cylinder around it by means of its wave of root-hairs. Then follow tunnelings along the lengths of each of these rootlets, and on all sides at right angles to them, until every nook and cranny has been investigated by these enterprising rootlets and their prying root-hairs. Quite apart from all else, therefore, the root-system obtains a greater and greater holdfast on the soil by driving its tips in on all sides.

But I must now draw your attention to some matters which throw even more light on our subject. The root-hairs, as they develop successively from above downwards on the primary root, or on the lateral rootlets, come into the closest contact with the particles of soil—contact so close and firm, in fact, that they cannot be torn away without injury. There are experiments to prove that their cellulose walls become actually moulded and gummed on to the solid particles of quartz, slate, and other rocks of which ordinary soils are composed, and this diagram shows how we can lift up a relatively large cylinder of soil adhering to the root-hairs of a young seedling.

Now you are probably aware that the sort of soil in which a healthy plant flourishes contains air-bubbles as well as water in the interstices between the particles, and into which the root-hairs become insinuated. Bearing this in mind, you will have no difficulty in understanding from the diagram how the root-hairs absorb the aërated water necessary for their well-being. I need simply make the additional remark that each little bag-like root-hair takes up the liquid water through its permeable walls into its interior, in some respects very much as a bladder full of a solution of sugar or salt would absorb water if placed in it.

But this water taken up by the root-hairs and passed on into the rootlets and so on up the stem (a process for which provisions are made which we cannot go into here), is not pure water; it contains, besides air, certain small proportions of the soluble matters found in all soils. It is, in fact, much like ordinary drinking-water from a well or spring, which always contains some matters in solution. But the roots want certain other minerals, which will not dissolve in pure water to a sufficient extent under ordinary circumstances. Well, the root-hairs, in making use of the oxygen which they, like all other living bodies, require, give off small quantities of acids which aid the solution of these more refractory matters.

And now I have finished—not because the subject is exhausted, but because the time at our disposal is. I hope the object has been attained, and that you fully realise how well worthy of study is a common living ro t. Not only is it instructive as a simple object of dissection, a subject upon which I have had no time to dwell, but the peculiar properties which stamp it as a living organ themselves afford material for much thought and investigation. When we go further, however, and see how the structure and the functions depend upon one another, some very curious reflections thrust themselves upon us; and if time had allowed us to look at these matters from the other platforms of view—to see how old errors have gradually been explained away on the part of observers, and how what may be called improved adaptations have arisen in the evolution of the root as an organ—these reflections would have obtained in depth. But we have taken a glimpse at matters still more comprehensive: we have touched upon that important question of the relation of the root to its physical environment, and it is not difficult to see numerous points where the struggle must have been intense before the plastic substance of the root was enabled to meet the requirements necessary before it could become a dweller in the land. The evidence of progress and adaptation to its environment on the part of the root is, in fact, so striking and conclusive, that we might take it as a text for a sermon on evolution were such necessary. I have been strongly tempted to occupy some more time with reference to the interesting phenomena shown by roots which cling to trees and walls, &c., or which rob other plants of food-materials; and had time allowed, I would have liked to say a few words about some other adaptations, such as those by means of which roots become pulled up taut in the soil. However, these and other matters cannot be even mentioned, and, indeed, each one deserves a lecture to itself.

FOCAL LINES

WHEN a pencil of light proceeding from a luminous point is incident upon a prism, the rays after refraction do not as a rule diverge from a point, but from two short lines at right angles to each other at some distance apart depending on the angle of incidence of the pencil. These lines are known as the focal lines of the pencil. If the edge of the prism be vertical and the axis of the pencil lie in a horizontal plane, the focal lines are respectively horizontal and vertical. The position of the horizontal line is independent of the angle of incidence of the pencil, its distance from the prism being the same as that of the luminous point, or with the notation of Parkinson's "Optics" (p. 88)—

$$v_2 = u.$$

The distance from the prism of the vertical focal line is, on the other hand, dependent on the angle of incidence, its position being given by the formula—

$$v_1 = \frac{\cos^2\phi' \cos^2\psi}{\cos^2\phi \cos^2\psi'} . u.$$

The image of an object viewed through the prism will appear between the two focal lines, and will be formed by the circles of least confusion. The two focal lines will coincide in position, and they, and the circles of least confusion, will consequently become points if $\phi = \phi'$, that is, if the prism be placed in the position of minimum deviation.

All these phenomena of refraction by a prism, which are of great importance to the spectroscope, may be verified in a very striking manner by using as an object a piece of wire gauze, placed so that one set of wires is horizontal and the other vertical, and illuminated by a sodium flame placed behind it. If the light pass directly from the gauze to the prism, the focal lines are of course virtual, but they may be easily viewed and their positions identified by means of a telescope which will focus an object at a short distance. For one position of the eye-piece of the telescope the vertical wires are seen distinctly while no horizontal wires are seen; whereas for another position the horizontal wires may be focused, but then the vertical ones are no longer visible unless the prism is in the position of minimum deviation. Between these two positions of the eye-piece is a third, for which a blurred image of the gauze is seen corresponding to the circles of least confusion. The positions of the lines may be determined by ascertaining where an object must be placed, when the prism is removed, so as to be in focus in the telescope for the two positions of the eye-piece corresponding to the two focal lines respectively.

The experiment is, however, much more striking if the focal lines be made real by interposing between the gauze and the prism a convex lens of somewhat long focal length. The vertical and horizontal images may then be viewed by means of an ordinary watchmaker's glass, or, better still, by a telescope eye-piece mounted behind a second gauze with its wires set at 45° to the horizon. With this arrangement the images corresponding to the two focal lines can be seen very clearly, and their distances from the prism accurately measured. It is very interesting to place the prism first in the position of minimum deviation, and focus the magnifier upon the image of the gauze, showing both horizontal and vertical wires clearly defined; then on gradually turning the prism the vertical lines disappear completely, leaving a set of horizontal bars across the uniform field, thus verifying the first formula cited above.

If however, the eye-piece be drawn back some way, a badly-defined image of the gauze can be obtained corresponding to the circles of lea t confusion, and, on withdrawing the eye-piece still further, the horizontal lines disappear entirely, while the vertical lines come out sharply defined as a set of vertical bars across a uniform field. As the experiment was arranged here, with a prism of about 9° and the horizontal focal line about two feet from the prism, the distance between the two images was fully six inches when the prism was turned through an angle of about 15° from the position of minimum deviation.

The properties of the focal lines formed by a pencil incident

obliquely upon a lens can be verified in an exactly similar manner. It follows from the formulæ given in Parkinson's "Optics" (p. 101) that, with the usual notation—

$$\frac{u - v_1}{u - v_2} \cdot \frac{v_2}{v_1} = \sec^2\phi.$$

The verification of this formula by the method of observation described above has been found to be a very useful and satisfactory class experiment. W. N. SHAW

Cavendish Laboratory, Cambridge

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The election of Mr. A. Marshall as Professor of Political Economy will be welcomed by all who knew the value of his work when formerly in residence as Lecturer at St. John's College.

The Senate has sanctioned the recommendation that 700*l.* be expended on the purchase of microscopes for the biological classes, on which sum interest at 4 per cent. is to be paid, a small terminal charge being made to the students for the use of the microscopes.

The Botanic Garden Syndicate have recommended the increase of the stipend of the Curator of the Botanic Garden from 150*l.* to 200*l.* The Syndicate have watched with interest the zeal and skill with which Mr. Lynch has applied himself to the conduct and development of the garden. The improvement during his curatorship has been very considerable, in fact remarkable; and the reputation of the garden among botanists and horticulturists, both at home and abroad, has risen so much that it is now considered to hold a place in England second only to the Royal Gardens at Kew. Sir Joseph Hooker has said that the Garden, under Mr. Lynch's able management, is rapidly rising to eminence as one of the very best in Europe. The Syndicate express their strong approval of the assistance which Mr. Lynch's intelligent appreciation of the requirements of botanical teaching has enabled him to render to the University.

DR. GILBERT, Professor of Rural Economy at the University of Oxford, and the associate of Sir J. B. Lawes in the Rothamsted experimental work, has accepted the post of Honorary Professor of Agricultural Chemistry at the Royal Agricultural College, Cirencester, rendered vacant by the death of Dr. Voelcker.

MR. D'ARCY WENTWORTH THOMPSON, B.A., was on Monday elected Professor of Biology, University College, Dundee.

SOCIETIES AND ACADEMIES

LONDON

Physical Society, December 13.—Prof. Guthrie, President, in the chair.—The following communications were read:—On the effect of an electrical current on the rate of thinning of a liquid film, by Profs. A. W. Reinold, F.R.S., and A. W. Rücker, F.R.S., read by Prof. Reinold. In 1877 the authors communicated to the Royal Society an account of some experiments upon the electrical resistance of liquid films. The results then obtained showed that there was some disturbing influence present, and the authors now find this to be the action of the current upon the film itself. The films experimented on were, as in the original experiments, cylindrical and vertical, formed upon two coaxial platinum rings which are the electrodes by which an electric current can enter or leave the film. The mode of formation of these films and the precautions necessary to keep them from gaining or losing moisture by condensation or evaporation have been already described before the Royal Society (*Phil. Trans.*, 1881, part 2). When such a film, just formed, is left to itself, it shows a set of colours of different orders arranged in horizontal bands; as it thins under the action of gravity, these bands gradually broaden out, and descend; a black band soon appears at the top, which likewise extends downwards. If a current is now passed downwards through the film, the motion of the colour-bands is accelerated, showing that the effect of the current is to assist gravity in thinning the film; the black band, however, becomes in part or entirely white. This upon examination is found to be due to the following action; the film is not directly dependent upon the upper ring, but is attached to it by a comparatively thick mass of liquid. The action of the current is to transfer liquid in its own direction, thus, like gravity, thinning the film; the mass of liquid, however, on which the film hangs, by this same action is forced down into the black portion, which consequently becomes white. If the current be passed upwards, the reverse effects occur: the downward motion of the bands is retarded, or, with a strong current, reversed. The explanation is precisely the same as before: the liquid is transferred along the film in the direction of the positive current; it sometimes collects in the form of pendent drops attached to the upper ring; these increase in size, and stream down the sides of the film. Prof. Reinold then formed a plane film between two horizontal wires; the film was illuminated by the lime-light, and its image projected upon a screen; the motion of the bands of colour in the direction of the current produced by fifty Grove's cells was clearly shown.—In a discussion which followed upon the transference of matter with the current, Prof. Ayrton described some experiments recently made by Prof. Perry and himself, which showed that certain metals were carried through mercury in the direction of the current. Mr. Boys remarked upon the apparent inertia of the film; the current seemed to require time to develop its action, no motion of the colour-rings being visible for some seconds after making the current.—Dr. Stone exhibited a tuning-fork interruptor commutator. This is an instrument for reversing an electric current through a circuit a given number of times per second. From the free end of a spring, kept vibrating in unison with an electrically maintained fork, by an electromagnet in the circuit of the fork acting upon an iron armature attached to the spring, project two small aluminium plates, side by side, but insulated by ebonite from the spring and from each other. These are connected by fine wires, which do not interfere with the vibration of the spring, to screws upon the base of the instrument, to which the poles of a battery are joined. The motion of each plate is arrested upwards and downwards by aluminium-stops, so that there are four such stops arranged at the corners of a rectangle. They are connected in pairs diagonally, and each pair is in communication with one end of the external circuit. Thus, when the spring is up, the current flows to the aluminium plates, and is transmitted through the circuit in one direction; when the spring is down, it flows by the lower stops in the opposite direction. The electromotive force is thus reversed in the circuit twice as many times as the fork vibrates per second.—Mr. Lewis Wright exhibited his new oxy hydrogen lantern microscope. Details of this instrument will shortly be published. Geological, medical, and biological specimens were exhibited upon the screen with great distinctness, the definition being singularly perfect under the highest powers.

Anthropological Institute, December 9.—Prof. Flower, F.R.S., President, in the chair.—The election of Miss Müller was announced.—Sir John Lubbock read a paper on marriage customs and relationships among the Australian aborigines. Many tribes are divided into families or gentes, and no man may marry a woman of his own gens. For instance, among the Mount Gambier (South Australia) natives every man is a Kumite or a Kroki, every woman a Kumitegor or a Krokigor. No Kumite may marry a Kumitegor, nor a Kroki a Krokigor. In many cases the divisions are more complex, but the general principle is that no man may marry a woman of the same gens as himself. These divisions often extend through many tribes and over hundreds of miles. But while these restrictions are imposed on marriage, on the other hand, in one sense, every man is considered as a husband of every woman belonging to the gens with which he is permitted to marry; so that, as Messrs. Fison and Howitt forcibly put it, he may have 1000 miles of wives. But though we may call this marriage, and it is a right which in old times was generally, and to a certain extent still is, recognised as perfectly legal and respectable, it does not help us to the origin of marriage in our sense. "Communal marriage" (as he had proposed to call it) was no doubt aboriginal, and founded on natural instincts. But how did the institution of "individual marriage" arise? "Individual marriage" cannot be derived from "communal marriage," because, however much the gentes may be subdivided, the wives must remain in common within the gens. Messrs. Fison and Howitt did not, he thought, sufficiently realise the fundamental distinction between these two customs. They spoke of both as "marriage," and indeed we had no other word for them. Yet they were radically distinct, and even opposite in their characteristics. Sir John Lubbock had suggested, in his work on the "Origin of Civilisation," that, while in such a state of things no man could

appropriate a woman belonging to his own tribe exclusively to himself, still that, if he captured one belonging to another tribe, he thereby acquired an individual and peculiar right to her, and she became his exclusively, no one else having any claim to, or property in, her. He considered that this explained the prevalence of the form of capture in marriage, first pointed out by the late Mr. McLennan in his excellent work on "Primitive Marriage," but which Mr. McLennan attributed to the prevalence of exogamy, or the custom of marrying outside the tribe; while, on the contrary, Sir John Lubbock maintained that individual marriage was founded on capture, because this could alone give a man an exclusive right. This view has recently been contested by Messrs. Fison and Howitt, but Sir John replied in detail to their arguments, and supported his suggestion by strong evidence, some even taken from their own work.—The Director (Mr. Rudler) read a paper on the Jeraeil or initiation ceremonies of the Kurnai tribe, by A. W. Howitt, F.G.S., in which the author gave a detailed account of a Jeraeil at which he himself was present, and drew attention to the manner in which it differs from, or has resemblance to, the Kuringal of the Murring.

EDINBURGH

Royal Society, December 1.—Thos. Stevenson, C.E., President, in the chair.—Mr. Stevenson made some remarks in connection with his election as President.—Sir W. Thomson communicated a paper on the distribution of energy between colliding groups of molecules, in which he drew attention to Boltzmann's extension of a theorem given by Clerk Maxwell for the first time twenty-four years ago. He pointed out that, while Maxwell made his simple theorem the basis of his kinetic theory of gases, Boltzmann's extension would, if true, be fatal to that theory. Prof. Thomson also stated that the proofs of Boltzmann's theorem are not satisfactory. The theorem itself seems improbable, and cannot be accepted unless rigidly demonstrated. He wished to draw the attention of mathematicians to the subject, so that the truth of the theorem might be tested. Prof. Crum Brown remarked that, even in the simplest cases to which the theorem might be applied, there seemed no accordance between its results and actual fact. Prof. Tait stated that the truth of the theorem had seemed to him to be so doubtful that he had called the attention of the Society to it two sessions ago, and had also referred to the matter in his recently-published book on "Heat."—Sir W. Thomson then communicated a paper on the dynamics of reflection and refraction in the wave-theory of light. He gave a complete mathematical theory of reflection and refraction of light supposed to consist of vibrations in homogeneous elastic media of different densities and rigidities in the two substances through which the light was considered to pass. The theory confirmed the views of Stokes, Lorenz, and Rayleigh, that the density of the luminiferous ether is different in different transparent substances, while its effective rigidity is equal.—Sir W. Thomson then gave a paper on Kerr's discovery regarding the reflection of light from a magnetic pole. Kerr's discovery forms an extension of Faraday's observations on the action of magnetism on polarised light passing through transparent substances. The plane of polarisation of light reflected from a polarised magnetic pole is rotated through a definite angle in a direction opposite to the conventional direction of the Amperian current. Some time passed before Kerr's results were obtained by any other observer. Kundt finally succeeded in verifying them, and added the new discovery of the rotation of the plane of polarisation of light passing through a transparent film of iron. In his paper Sir W. Thomson gave a dynamical explanation of these phenomena.—Prof. Tait exhibited a new form of apparatus for determining the compressibility of water. Formerly he measured the compression produced by a given pressure. In his new method he measures the pressure required to produce a given compression. His arrangement allows him to make any number of measurements in rapid succession at any one temperature. Then the temperature can be raised, and corresponding measurements made without once opening the compression-apparatus. Thus experiments which formerly would have taken weeks for their completion could now be accomplished in a single afternoon. Rude results only have been obtained as yet with the old very massive compression-apparatus. These seem to show that the diminution of compressibility at higher pressures becomes less at higher temperatures, and may possibly even become an increase for the first few hundred atmospheres pressure. But no very definite statements can be made till the new, light but strong, apparatus now being made is available for experiment.

PARIS

Academy of Sciences, December 15.—M. Rolland, President, in the chair.—On the forms of the surface of the luminous wave in an isotropic environment situated in a uniform magnetic field: probable existence of a peculiar double refraction in a direction normal to the lines of force, by M. A. Cornu.—On the algebraic relations between the hyper-elliptic functions of the n-order, by M. Brioschi.—On the determination of a special case of isomerism in the acetones, by M. G. Chancel.—On a method of inoculating the large ruminants with the virus of tuberculosis, by M. G. Colin. The experiments made on these animals afford a means of exactly measuring the period of incubation of the tuberculous elements, and determining the time required for the tubercules to pass to the state of transparent granulation.—On the variations of the ozone present in the atmosphere during the late outbreak of cholera in Paris and Marseilles, and on the advantages obtained from ozoneine, by M. Onimus. In both places there was a perceptible diminution of the atmospheric ozone during the prevalence of the epidemic, while a marked difference was observed between the ozonometric condition of the air this year compared with the preceding. In Marseilles the mean for July of this year, when the epidemic was at its height, was 0·86; that for the corresponding period in 1883 as high as 2·17. In Paris the mean for November was 0·44 and 1·82 respectively. The author infers, not that the absence of ozone is the cause of the disorder, but that it is a favourable condition for its development, while it is certain that the presence and persistence of ozone helps materially to arrest its progress. His experiments with Beck's preparation of ozoneine on men and animals were attended with excellent results, and produced no ill effects, even when administered in large doses. Its action affects chiefly the central nervous system, on which it produces a sedative effect, tending to show that this region is the main seat of the malady.—On the theory of the figure of the planets, by M. O. Callandreau.—On a trigonometric formula of interpolation applicable to any values of the independent variable quantity, by M. G. Fouret.—On the sections of mathematical functions, by M. Laguerre.—On the conditions necessary to determine the photometric value of intense foci of light, whether electric or solar, by M. Berthelet.—On some processes of practical spectroscopies, by M. Eug. Demarçay.—On the mutual attraction of bodies in solution and of solid bodies immersed, by M. J. Thoulet. The author shows that, when a salt is dissolved and a solid body immersed in the solution, an attraction is set up between the two substances altogether independent of any chemical action, and that this attraction is in direct proportion to the surface of the solid body.—Note on the dissociation of the hydrate of chlorine, by M. H. Le Chatelier.—Contributions to the study of brucine, by M. Oechsner de Coninck. It is shown that, like cinchonine, brucine contains in its molecule a tetrahydruret of quinoleine. Thus is again confirmed Wischnegradsky's hypothesis that the pyridic and quinolic bases exist in the state of hydrurets in the fixed alkaloids.—On the formation of the shell of the egg of *Scyllium canicula* and *Scyllium catulus*, by M. E. Perravex.—On the biological development of the Chelifer group of Arachnida, by M. Ch. Robin.—On the structure of the digestive apparatus of *Cantharis vesicatoria*, *Epicauta verticalis*, *Lytta fabricii*, *L. atrata*, and some other members of the Cantharides group of insects, by M. Alph. Milne-Edwards.—On the anatomical structure of the peduncles, compared with that of the ordinary axes and of the petioles in plants, by M. E. Laborie.—Account of two specimens of abnormal growth in the mushroom family, by M. Ed. Heckel.—Generic characteristics of Pleuraspidotherium, a mammifer of the Lower Eocene formations from the neighbourhood of Rheims, by M. V. Lemoine.—On the fossils of the Carboniferous strata found in a well recently sunk at Lubière in the Brassac Basin, by M. Grand'Eury.—Note on the periodical recurrence of the crepuscular glows, by M. J. J. Landerer. The recent reappearance of this phenomenon precisely at the same period as last year is regarded by the author as an argument in favour rather of a cosmic than of a volcanic origin.—M. Mascart was elected a member of the Section of Physics, to replace M. Jamin, recently appointed Perpetual Secretary.

BERLIN

Physiological Society, November 14.—Dr. König spoke on colour-blindness. A ray of light decomposed by calc-

spar into two polarised beams perpendicular to each other showed, after passing through a quartz plate, when viewed through a Nicol prism, two halves of different colours in the field of vision of the ocular lens, the colours of these halves varying with the position of the Nicol prism. In the case, however, of a so-called colour-blind or bichromatic eye there was a position of the Nicol prism in which the two different colours in the halves of the field of vision appeared alike. The position in which the colours appeared alike was not always the same, but varied with the thickness of the quartz plate, with the intensity of the light examined, and with the individuality of the bichromatic eye. An instrument of this description was therefore an apparatus that might be depended on for the detection of colour-blindness. Normal eyes, in whatever position the Nicol prism might be held, saw different colours; colour-blind eyes, when the Nicol prism was held in a certain position, saw similar colours. The person whose eyes were to be tested was made to look through the apparatus towards one or other source of light, and if at last, after a greater or less number of turns of the Nicol prism, he saw but one colour, then that person was proved to be colour-blind. The examination of a large number of persons—about fifty—who confounded red and green colours, usually distinguished as red- or green-blind, resulted in showing that, with an equal intensity of light, and with the same apparatus, a part of the colour-blind, on the Nicol prism being placed in a certain position, saw similar colours, while the remainder observed a corresponding similarity of colours with another position of the Nicol prism, this second position producing the same result for all persons of that category. The colour blind being by this means separated into two sharply-defined groups, neither shading into each other nor into the group of normal eyes, it was a matter of much interest to investigate whether these two groups of colour-blind eyes showed any other characteristic peculiarities. Among the methods adopted for determining the colour-blind, that of examining their spectrum, which was said to appear always shortened in different ways in the different cases of the red- and green-blind, was largely applied. It was seen, however, that there were so many particulars to be taken into account as affecting the extent of the spectrum, even in the case of sound eyes, that that method was by no means available for the precise and distinctive measurements here required. Another method, that of determining the neutral point, seemed well adapted for exact physical utilisation. As was known, Young's theory of the perception of colours assumed that in the retina there were three different nerve-elements perceptive of colour: one perceiving red, another green, and the third violet. If the perceptive capacities of each of the nerve-elements were traced as ordinates on the spectrum as abscissæ, three curves would appear, of which the first would have its maximum in red, the second in green, and the third in violet. If all three nerve-elements were acted on with equal force by a stimulus of light, then the sensation of white was produced; but if they were affected in different degrees, then the sensation of partial colour was the result. In the case of the colour-blind there was, according to this theory, one curve wanting, the red, or green, or violet. The two remaining ones, in that case, must now cut each other in one point, and at the spot where this point hit the spectrum, the colour-blind person, his colour-perceptive elements thereby being affected with equal force, must see white: at that spot was the neutral point. The finding of this neutral point by means of a movable slit through which a spectrum could be viewed was, however, attended with several inconveniences prejudicial to precision. Dr. König had therefore constructed a special apparatus for ascertaining the neutral point. [This was described at length by the speaker in his communications to the Physical Society, NATURE, vol. xxix. pp. 168, 496.] In nine persons, some of whom were red, and others green-blind, the neutral points were determined, and the following observations made: (1) The neutral point was able to be measured with great precision in each case of colour-blindness, the average error being at the greatest, 0·4 millionth of a millimetre, wave-length, and in the least 0·1 millionth of a millimetre. (2) The neutral point in the case of all colour-blind persons, green- as well as red-blind, was situated at one spot of the spectrum, in the green blue, between the wave-lengths 492 and 505 millionths of a millimetre. A division of the colour-blind into two groups, such as could be so exactly carried out with the leucoscope, was, however, not possible through determinations of the neutral point, for on the leucoscope colour-blind persons of different descriptions had their neutral points quite close to each other, while eyes leucoscopically alike had their neutral points most remote from each other. (3) With increasing intensity of light the neutral point was displaced in all cases of colour-blindness towards the more refrangible end of the spectrum. Among the results of the measurements referred to, that cited under (2) was of extreme interest for the theory of colour-blindness. One conclusion it yielded was that the idea of the nature of colour-blindness derived from Young's theory received no support from the experimental examination of the consequences deduced from it. Dr. König had occasion quite recently to examine a so-called violet-blind person, and another who was totally colour-blind, but he had not yet had time to reduce the measurements he had carried out respecting these two cases, and would therefore reserve further particulars of them to another opportunity. The fact established in (1), that with the apparatus constructed for ascertaining the neutral point separate small sections of the spectrum may be so sharply marked off and determined according to their undulatory length, induced Dr. König to make use of this apparatus for investigations respecting the colour-perceiving capacities of normal eyes. In co-operation with Dr. Dietrici he had first examined the degree of sensitiveness to distinctions of colour in the different parts of the spectrum between 650 and 430 millionths of a millimetre, undulatory length, and gave a summary of the results thereby obtained which he had already communicated to the Physical Society (NATURE, xxix. 496, xxx. 308). It deserved here, however, to be brought prominently forward that the maximum of colour-sensibility of the two normal eyes coincided with that spot of the spectrum at which the neutral point occurred in the colour-blind, and that this maximum of colour-sensibility shifted, in the same way as the neutral point, with increase of the intensity of light towards the blue end. The further investigations contemplated by Dr. König relate to the colour sensibility beyond the wave-lengths 650 and 430 millionths of a millimetre, and determinations in regard to colour-contrast.

CONTENTS

THURSDAY, JANUARY 1, 1885

THE "AMERICAN JOURNAL OF MATHEMATICS"

American Journal of Mathematics, Pure and Applied. Published under the Auspices of the Johns Hopkins University. Vols. v., vi., vii., Part I. (Baltimore: Isaac Friedenwald, 1882-4.)

THE general features of this *Journal* have been clearly indicated in the notices of the previous volumes (see NATURE, vol. xxii. p. 73, vol. xxvii. p. 193), and we need only remark under this head that these original characteristics have been maintained throughout the numbers now under our consideration.

Prof. Sylvester was the editor-in-chief until his return to this country; now the mantle has fallen upon his successor, Prof. Newcomb, under whose auspices vol. vii. is being published. Dr. Thomas Craig has been the assistant editor during the issue of all the numbers.

The chief papers treat of the higher algebra. In this branch the contributions of Prof. Sylvester naturally loom large. They are "On Sub-Invariants, *i.e.* Semi-Invariants to Binary Quantics of an Unlimited Order," "Tables of Generating Functions, reduced and representative for certain Ternary Systems of Binary Forms" (the "Tables" were calculated by Messrs. Durfee and Ely), "A Constructive Theory of Partitions, arranged in Three Acts, an Interact, and an Exodion," a most valuable contribution to the theory, written with the author's characteristic fervour, but perhaps the gem of the collection is the first instalment of the "Lectures on the Principles of Universal Algebra."

We naturally turn next to the papers by Prof. Cayley. These are a "Note on a Partition-Series," "A Memoir on Seminvariants," following up a "remarkable" discovery by Capt. Macmahon, which leads to the conclusion that the theory of seminvariants is a part of that of symmetric functions, and three sets of tables, viz. non-unitary partition tables, seminvariant tables, and tables of the symmetric functions of the roots, to the degree 10 for the form—

$$1 + bx + cx^2/1 \cdot 2 + \ldots = (1 - \alpha x)(1 - \beta x)(1 - \gamma x) \ldots$$

Following in the wake of these leviathans, Mr. Durfee contributes "Tables of the Symmetric Functions of the Twelfthic," and "The Tabulation of Symmetric Functions"; Capt. Macmahon writes on "Seminvariants and Symmetric Functions," "Symmetric Functions of the 13^{ic}," and "On Perpetuants"; he is also the author of a short "Note on the Development of an Algebraic Fraction," the moving cause of which is a previous article by M. Faà de Bruno, entitled "Sur le développement des fonctions rationnelles," which in its turn owed its origin to a note by Prof. Sylvester in the *Johns Hopkins Circulars.* Mr. J. Hammond, another worker in this field, has a paper "On the Solution of the Differential Equation of Sources," in which he gives a disproof of Prof. Sylvester's fundamental postulate, a discovery which he first communicated to the London Mathematical Society. Mr. G. S. Ely applies the method of graphs to compound partitions, and Mr. Morgan Jenkins gives a proof of a theorem in partitions, and furnishes a note on Prof. Sylvester's constructive theory of partitions, mentioned above.

We pass from this group of subjects, which centres more especially round the name of Sylvester, and come to papers on elliptic functions in one or other of the forms under which that branch is now ranged. M. Faà de Bruno has a long article on "Quelques applications de la théorie des formes binaires aux fonctions elliptiques"; Dr. Craig contributes several papers, viz. "Some Elliptic Function Formulæ," "On a Theta-Function Formula," "On Quadruple Theta-Functions" (two papers), "On Theta-Functions with Complex Characteristics," and "On Certain Groups of Relations satisfied by the Quadruple Theta-Functions." Prof. W. W. Johnson presents a proof of the imaginary period in elliptic functions; Mr. A. L Daniels communicates three notes on Weierstrass's methods in the theory of these functions; and Prof. Cayley, in a memoir on the abelian and theta functions, reproduces, with additional developments, the course of lectures which he delivered at the Johns Hopkins University in the early months of 1882.

The other papers on algebraical subjects may be grouped together. They are:—"On Division of Series," by Rev. J. Hagen; "Tables for Facilitating the Determination of Empirical Formulæ," by A. W. Hale; "On the Development of an Algebraic Fraction," by Dr. Franklin; some papers "On the Theory of Numbers," by A. S. Hathaway; "Sur une formule relative à la théorie des fonctions d'une variable," by M. Hermite; "Calculus of Direction and Position," by E. W. Hyde; "Compound Determinants," by C. A. Van Velzer (written before the author had seen Mr. R. F. Scott's paper in vol. xiv. of the London Mathematical Society's *Proceedings*), in which is discussed Picquet's proof of a theorem of Sylvester's. Mr. McClintock writes on the resolutions of equations of the fifth degree, a subject which is also handled by Mr. G. P. Young, who in addition discusses the principles of the solution of equations of the higher degrees. Mr. G. S. Ely furnishes some notes on the numbers of Bernouilli and Euler (adopting a name given by Sylvester), and gives a useful bibliography of Bernouilli's numbers. Such lists as these are of great service to workers.

Dr. Story defines the absolute classification of loci to be that classification which is not altered by any real linear transformation, and which is identical with the ordinary classification in so far as the latter is independent of all consideration of the nature of the infinite elements of the loci; a part of this classification has been made (as Dr. Story remarks) in essence by Prof. Sylvester in the *Phil. Mag.* (February 1851). The title of the paper is "On the Absolute Classification of Quadratic Loci, and on their Intersections with each other and with Linear Loci." The same author also contributes two articles on the non-Euclidian geometry: one is a continuation of a paper by him in vol. iv., and in it are given a number of formulæ relating to distances, angles, areas, and volumes; the other is entitled "Non-Euclidian Properties of Conics," and contains an application of Prof. Cayley's projective measurement, generalised by Klein, and still further extended by the author in the paper just cited, to the conic.

Dr. Franklin discusses some points in the theory of

cubic curves by a novel method, but not many new theorems are the result; and Mr. E. W. Davis gives an expression for the co-ordinates of a point on a binodal quartic curve as rational functions of the elliptic functions of a variable parameter.

The only purely geometrical article is one by Mr. B. Alvord, entitled "The Intersection of Circles and the Intersection of Spheres." The problems discussed are to draw a circle which shall make a given angle with three given circles; to draw a sphere which shall cut each of four given spheres at a given angle; and then two Steinerian problems, viz. to draw a circle which shall cut four given circles at the same angle (angle unknown), and the analogous problem for five spheres. The number of solutions in each case is given, and there are four plates containing thirteen figures. Prof. C. H. Smith supplies a graphic method of solving spherical triangles.

There is a single astronomical article on certain possible abbreviations in the computation of the long-period inequalities of the moon's motion due to the direct action of the planets, by Mr. G. W. Hill, who states that Hansen has characterised the calculation of the coefficients of these inequalities as extremely difficult, but he himself thinks that, if the shortest methods are followed, there is no ground for such an assertion.

Prof. Turazza gives a note (which the editor had mislaid for three years), "Di un nuovo teorema relativo alla rotazione di un corpo ad un asse."

The only physical paper is Prof. Rowland's, "On the Propagation of an Arbitrary Electro-magnetic Disturbance on Spherical Waves of Light and the Dynamical Theory of Diffraction." The classical paper by Stokes "On the Dynamical Theory of Diffraction" is discussed; in addition the author treats of the general problem of spherical waves of light, which he has not seen considered anywhere else.

We think the titles of the papers and a perusal of their contents quite bear out Mr. Glaisher's opinion, pronounced in his notice of the previous volumes (vol. xxvii. *ubi supra*), viz. that "the volumes represent a considerable amount of mathematical work, a fair proportion of which may have real influence on the advancement of the science." Some readers might like to have a more diversified bill of fare set before them, but no one can say that what is offered is not generally first class. The form of the *Journal* lends itself admirably to the important tables with which it has been enriched from its earliest days. We are glad to find this young work maintaining its early promise, and we wish for it even a higher success in the days to come.

A SYSTEM OF PSYCHOLOGY

A System of Psychology. By Daniel Greenleaf Thompson. 2 vols. (London: Longmans, 1884.)

PSYCHOLOGY, like other sciences, may be regarded as a pure science, or as a set of generalisations capable of application to practice, or as material for a philosophical construction. Mr. Thompson has treated it, for the most part, in the spirit of a scientific inquirer. He does not stop to make applications to practical questions, and although he is not without metaphysical views of his own, it is evident that he is interested in psychology more for its own sake than for the sake of its bearing on his theory of the universe. There is, therefore, no need to discuss here the questions in dispute between the empirical school to which Mr. Thompson belongs and its various critics. As he has treated psychology so much in the scientific spirit, we may confine ourselves to indicating the kind of work he has done in his own special line.

Some have denied that psychology is a science, on the ground that it does not make progress; but it is only necessary to compare Locke's "Essay" with any modern work in which the treatment is not altogether inadequate, in order to see that progress has been made both in accuracy of description and in refinement of analysis of psychological facts. The admiration that must be felt for what Locke was able to do only makes the comparison more conclusive so far as the establishment of the scientific character of psychology is concerned. In criticising any new book, then, we ought to ask whether the author has made any advance on his immediate predecessors. We ought, in fact, to apply to the particular author we are criticising the test of progress to which psychology as a whole may be submitted. Mr. Thompson's book will emerge successfully from an examination such as that which is here suggested. In dealing with many special questions he goes beyond the later English psychologists just as they themselves have gone beyond Locke.

A student might very well begin with the sixth part of Mr. Thompson's book, entitled "The General Development of States of Consciousness," in order to get at the author's more important results, and then read the parts that come before it to understand more fully his general view of his subject, and the parts that come after it for new details. In this division of his work, the author brings out very clearly the difference between "presentative" and "representative" states of consciousness, and shows the influence of this difference in the spheres of feeling and of will, as well as of cognition. Emotional states are classified according to their relation to the environment, which may take the form of "pleasurable interest in external objects" or of "aversion to external objects." The chapter on "volitional development" (the first of the second volume) deserves the special attention of the psychological student. Mr. Thompson's introduction into the view he gives of the external world in its relation to mind (in Part III.), of a sort of Cartesian conception of "matter" as including "space," must be at least alluded to as likely to be found interesting both by physicists and metaphysicians. Although philosophy and science are now too much specialised for an idea of this kind to have any direct influence on research, yet all discussion between philosophers and men of science of the more general terminology of the sciences, and especially of physics, must have some effect in compelling clear definition of terms on the part of physicists and at the same time in keeping philosophic thought in contact with its basis of scientific law.

Mr. Thompson might perhaps have given a better account of the introspective method in psychology if he had had fuller possession of the idea of mind as something common to all individuals; if he had been able to show more clearly that it is not simply the individual

mind, but rather the general human mind, that the psychologist analyses. His omission to make it clear that psychology is really the science of human nature, and not a mere description of the mental states of an individual, or of as many individuals as possible, does not, however, destroy the value of his results. When he describes the science of psychology as being a sort of resultant of the contributions of various people who "chronicle their states," this is only an imperfect description of the method of psychology and of what it implies. To state the case in this way is to lose sight of the fact that society is an organism, and to consider it as an aggregate of isolated individuals; but, without any elaborate analysis, we may show that the introspective method of Mr. Thompson and of the older psychologists really implies more than the examination of any number of individual minds merely as such.

There is probably quite as much minute observation of mental states to be found in literature with no scientific pretensions,—in novels and autobiographies, for example, —as in books of psychology. Why has this kind of "introspection" first of all a literary, and only secondarily a scientific, interest? Is it not because the states of mind described are regarded as states of a particular mind, because they are merely elements in the description of some one personality, because they have no distinct reference to a law of mind in general? Of course some things in books of psychology have only a personal interest, and some things in books of pure literature may have a scientific interest; but there is no difficulty in distinguishing the two kinds of "introspection" when we meet with them, or in recognising them as essentially different.

The scientific character of the introspective method as being one that yields general conclusions is quite evident in Mr. Thompson's book, in spite of his omission definitely to point out this character. It has already been said that his "System of Psychology" furnishes new evidence of the progressive character of psychological studies. We may conclude by saying that, although in some respects an unequal book, it is decidedly an important contribution of America to the treatment of psychology on the lines with which English readers are most familiar.

OUR BOOK SHELF

The Student's Flora of the British Islands. By Sir J. D. Hooker, K.C.B., &c., &c. Third Edition. (London: Macmillan and Co., 1884.)

THE lover and collector of our wild plants may congratulate himself on the number of botanists of the first rank who have devoted their energies to his service. Bentham, Hooker, and Babington have all of them written hand-books of the British flora, all of them excellent in their way. In the one now before us we have the well-known lucidity of description characteristic of the author combined with the most recent extensions of our knowledge as regards British plants. Very great care and labour have been expended in bringing the "Student's Flora" abreast of the most recent discoveries. The number of species of flowering-plants added to the British flora since the publication of the last edition in 1878 is not inconsiderable, indeed is surprising, considering the limited extent of the field and the number of workers on it. In addition to the introduction of these new species, the limits of species and sub-species have been carefully revised, and the "critical" genera submitted to the criticism of experts; the genus *Potamogeton* having been, in particular, revised by Mr. Arthur Bennett. Nor has the physiological side of the subject been neglected. For the first time, as far as I am aware, in any local flora of importance, the characters of the genera concerned in the process of fertilisation are given, especially those illustrated by the writings of the late Hermann Müller. Under the diagnosis of each genus it is stated—as far as is known —whether the plants belonging to it are wind-fertilised, insect-fertilised, or self-fertilised; whether honey is secreted in the flower or not; and whether the stamens and stigma ripen together, or, if not, which is the earlier. The result is that the field-student has now a hand-book of the characters of the plants that he meets with in wood and field, by stream and bog, and on the mountain-side, more complete than any which has heretofore been ready to his hand.

A. W. B.

Elementary Text-Book of Zoology. General Part and Special Part, Protozoa to Insectă. By Dr. C. Claus. Translated and edited by Adam Sedgwick, M.A., Fellow and Lecturer of Trinity College, Cambridge, with the assistance of F. G. Heathcote, B.A., Trinity College, Cambridge. (London: W. Swan Sonnenschein and Co., 1884.)

PROF. CLAUS'S "Elementary Text-Book of Zoology" has long been known as an excellent introduction to this branch of biology, and there was a certain charm in the way in which the introductory chapters, constituting the "General Part" of the work were written, that marked out the "Lehrbuch der Zoologie" as something different from many of the text-books that had preceded it. Its well-merited success in parts of the Continent where German is spoken is a matter of congratulation, and Mr. Sedgwick has translated it "with a view of supplying the want which," he tells us, "has long been felt by teachers as well as students in this country, of a good elementary text-book of zoology." It appears to us a pity that with this local demand for a good introduction to zoology, there should be apparently no other way of supplying it than by translating the works of our illustrious neighbours. It is certainly not the way that the schools of the great Continental centres are supplied, nor do we believe that it is from any want of original power to supply the need among our own zoologists. This view of the subject apart, the English student of zoology will find this translation of Claus's "Lehrbuch" a very excellent introduction. It is true that he may now and then note that it was not written for him, that the illustrations of specific forms referred to are not always, even when they might have been, within his easy reach; that some of the contributions of his countrymen are referred to as if they had first appeared in a foreign tongue, and that many very important ones are overlooked, but these will be scarcely difficulties in his way; and if they are, on application to an intelligent teacher they will be soon got over.

The original German has, with a few "unimportant exceptions, been closely followed throughout," but has it not been too closely adhered to, when it has been left altogether untranslated, as it apparently has been in the case of many very familiar families of insects? In some of these, too, the English equivalents are not perhaps of the best; thus Acanthiadæ (skin-bugs). In welcoming this attempt to introduce Prof. Claus's most useful work to the English reader we have no wish in any way to criticise the treatise in detail. It is got up in a very creditable manner, though a little more uniformity in the style of printing the technical words would have been desirable; thus, on the same page we find the words "Cirripedia" and "Malacostraca" in roman and in italic type, and specific names are not italicised in all cases,

while sometimes such English words as "insect," "spider," "scorpion" will be in one form of type, and sometimes in another. These are trifles, but still they are worth attending to, and they do not detract from the general merit of this translation, which we would freely place in the hand of any student.

Bosnien, Land und Leute. By Adolf Strausz. 2 vols. (Vienna, 1882-4.)

AFTER the occupation of Bosnia and Herzegovina by Austria in 1878, the want of an authoritative and comprehensive treatise on those hitherto neglected provinces of European Turkey soon became manifest. This want is fully supplied by the present work, on which the author has been engaged for the last four years, and for the composition of which he has qualified himself by repeated visits to the region he has undertaken to describe. The first volume, issued two years ago, is mainly historical and ethnographic, and embodies a complete history of the country, from the arrival of the Slavs in the fifth century, down to the Austrian occupation in 1878. Special sections are devoted to the various ethnical elements, Mohammedan and Christian Bosnians, Jews, Albanians, Zinzars, and Gypsies. These are all adequately treated, except the Zinzars (Macedo-Roumanians or Kutzo-Vlacks), the account of whom is confusing and even contradictory. The author seems unaware that their true relations to the surrounding populations, and especially to the Roumanians, now settled in Moldavia and Wallachia, north of the Danube, have been placed in a clear light by the recent investigations, especially of Roesler and P. Hunfalvy. The volume concludes with a series of social sketches, in which the habits and customs, legends, traditions, religions, national aspirations of the people are ably dealt with. The second volume, whose publication was delayed by various causes till the present year, is perhaps the more important of the two. It contains a complete description of the provinces, their geographical features, climate, fauna, flora, natural and industrial resources, administration, present condition and future prospects. On all these points the author speaks with great authority, and brings together a vast amount of information at first hand. Although bitterly opposed to the Austrian occupation, he believes that the inhabitants will eventually acquiesce in a step which political considerations had in any case rendered inevitable. The area of the country is given at about 52,000 square kilometres, an estimate based on recent but still incomplete surveys. The population, given by the Salname of 1877 at 2,047,000, was reduced by the census of 1879 to 1,158,000, of whom 448,000 were Mohammedans, 496,000 Orthodox Greeks, 209,000 Roman Catholics of the Latin rite, and 3400 Jews. The work unfortunately appears without either map or index, for which two meagre tables of contents are poor compensation.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Solar Corona and After-Glow

THE inclosed extract from a letter from the Rev. A. W. Heyde, resident at Kailang in Lahoul, a hill state in the North-West Himalaya (N. lat. 32° 34′ 10″, E. long. 77° 4′ 10″), 10,000 feet above sea-level, gives an interesting notice of the solar corona and after-glow, and affords some reason for the inference that the conditions producing these appearances have been persistent, although they may not have been observed in the cloudier and more hazy atmosphere over the plains of India. Mr. Heyde's letter is dated November 3:—

"The corona round the sun has been visible since my last letter to you in July, whenever the sky was clear. It was not always equally distinct, but never entirely absent. It is beautifully distinct to-day. The same has been the case with the after-glow, which no doubt results from [the same conditions as] the corona."

The following extract from the same letter is also of interest:—

"I think I have mentioned already, in former letters to you, that since about twelve or fifteen years the latter half of August and the whole of September and October have become very unsettled as regards the weather, rain or snow occurring now often during these months, which, as a rule formerly, were a time of fine, clear weather. These untimely precipitations interfere very unpleasantly with the haymaking and harvesting in the valley now nearly every year, of which many complaints are heard. . . . A similar experience is made in Ladak and other parts of the Western Himalayas. Officers who took part in the triangulation of Ladak during the four or five seasons between 1860 and 1870 say they never could have done their work if at that time the sky over Ladak had always been so cloudy, and the high ranges so frequently enveloped in clouds, as is now the case."

In corroboration of this last remark I may mention that the hopes that had been entertained of obtaining a valuable series of actinometric observations at Leh, for which purpose two trained observers were deputed to that station rather more than a twelvemonth ago, have been so far grievously disappointed. The atmosphere of Leh was believed, on the reiterated assurance of former residents, to be remarkable for its clearness and freedom from cloud and haze. From the actinometric registers received during the past year, and the notes which accompany them, this appears to be very far from the case.

HENRY F. BLANFORD

Meteorological Office, India, 4, Middleton Row, Calcutta, November 21, 1884

Flying-Fish do not Fly

FLYING-FISH *are incapable of flying* for the simple reason that the muscles of their pectoral fins are not large enough to bear the weight of their body aloft in the air. The pectoral muscles of birds depressing their wings weigh, on an average, $\frac{1}{6}$ of the total weight of the body, the pectoral muscles of bats $\frac{1}{13}$, the muscles of the pectoral fins of flying-fish only $\frac{1}{32}$. The impulse to which flying-fish owe their long shooting passage through the air is delivered, while they are still in the water, by the powerful masses of muscle on both sides of their body, which are of much greater breadth than in the case of the herring or any other fish of their own size.

The "flickering of the fins," which Dr. John Rae (NATURE, December 4, p. 102), like many others before him, takes for a rapid muscular movement of the pectoral fins, is only a vibration of their elastic membrane, and is to be referred to the same laws as those which govern the flapping of a tight-set sail when a ship under a stiff breeze is driving close to the wind. The flapping or vibration at once springs up whenever the sail gets parallel to the wind.

The more rapidly a flying-fish darts out of the water, the greater is the momentum with which the air presses on its outspread pectoral fins. Should, now, the atmospheric pressure induce these fins into a horizontal position parallel to the wind, their vibration is a necessary result. Let the outspread pectoral fins of a dead flying-fish be held horizontally before the opening of a pair of bellows, and the fins will be seen to vibrate as soon as the current of air passes under them. For full proofs of the accuracy of these propositions I beg to refer to my paper, "The Movements of Flying-Fish through the Air" (Leipzig, 1878).

Zoological Institut, Kiel, Dec. 15, 1884 K. MÖBIUS

Iridescent Clouds

IN addition to the particulars given in NATURE for December 18, 1884 (p. 148) of the brilliantly-coloured clouds, the following observations made here may be interesting. They were visible every day from the 6th to the 13th instant, except it be on the 9th, and at all times of the day, but only strikingly noticeable near sunrise and sunset. The colours did not appear

on them when they were very far from the sun, they then being simply white. I did not see any dark ones, as described by J. E. Clark; indeed they always struck me as being very thin, merely like a nearly flat sheet. They tended to be arranged in bands like "Noah's Arks," and, while their texture was smoother than most cirrus clouds, they were more or less striated transversely. On some afternoons I noticed in many cases a feeble smoke-like prolongation, or tail, on the east side of the cloud; this had no colouring. They had thus sometimes a striking resemblance to an aurora, differing essentially, however, in their real position being horizontal, while the auroral band and rays are almost vertical. Their direction also was quite different: on the 11th at 8·15 a.m., and 13th at 3·40 p.m. I noticed that the striæ pointed to east by south. In shape they approached parallelograms apparently; really, to rectangles; sometimes they were very perfect rectangles. One of the most striking clouds was, however, a perfect right-angled triangle in form. Their motion was very slow. Some time after sunset they were so bright as to give a material amount of light, and to make the dust-circle around the sun look quite dim. They were evidently at a great height, though they looked lower than the dust-wisps. They were incapable of producing an ordinary halo.

Like Prof. C. Piazzi-Smyth, I can say that I have no recollection of seeing any clouds of the kind before. I saw nothing like them at the time of the grand sunsets last autumn, and I think he is mistaken in supposing any of the phenomena then seen were of the same character. T. W. BACKHOUSE

Sunderland, December 22, 1884

REFERRING to the letters which have appeared in these columns on the subject of "Iridescent Clouds" as seen at Edinburgh and York on the evening of December 11, a very similar phenomenon was seen at Derby at sunrise on that day, and was thus described in the *Derby Express* the same evening:—"About half an hour before sunrise the eastern half of the sky was covered with a dense pallium of cirrus cloud. About 30° above the horizon was seen what appeared to be an elongated opening in the dark grey of the cloud. Through this spindle-shaped opening the sky was of an intense emerald colour. The strangest part of the phenomenon, however, occurred shortly before eight o'clock, when the vivid green had given place to a mass of brightness comprising all the prismatic colours arranged in bands transversely, each of the primary colours shading gradually into its neighbour in the same manner as in a solar rainbow. The appearance was now not unlike a huge many-coloured eye set in a dark uniformity of cirro-stratus. As the sun arose the colouring faded, and when the solar orb was several degrees above the horizon the phenomenon remained as a patch of brightness upon a silver-grey vapour, and was somewhat similar in appearance to an imperfectly formed parhelion. Its position, however, with regard to the true sun, showed at once that the phenomenon was not of the parhelion class"

C. J. P.

THE iridescent cloud effect mentioned by your correspondents (see NATURE, p. 148) was well seen here on the 13th about 4 p.m., and was very much as described by Mr. Clark. Three distinct bands of colour were seen just at the upper edge of a dark slate-coloured cloud towards south-west, and two faint ones on the clearer sky above. I write specially to remark on the nature of the colour of these bands. They were not *prismatic* colours as mentioned by Mr. Clark, but unmistakable *interference* or residual colours, the lowest bright purplish pink, shading into green, the next the peculiar light brick red seen in Newton's rings, and a very recognisable colour, also shading into green, and the rest pink and green, of similar colour to the lowest. There can be, I think, no question that this was an interference-phenomenon, and I hope some of your correspondents may be able to give the *rationale* of it.

Fairfield House, Darlington JAMES I'ANSON

I SEE notes in NATURE, December 18, 1884 (p. 148), on iridescent clouds. I observed similar appearances on the Yorkshire Wolds, between Market Weighton and Brough, on December 6 and again on December 13, 3-4 p.m.; but instead of the clouds being totally coloured, only the edges of rifts in a thick cloud-mass were so tinged. The phenomenon was much finer on the latter date, the rift being much larger and the colours more widely dispersed at one end, so that a rose tinge occupied there the whole of the acute angle of the gap.

Broseley, Shropshire W. W. WATTS

The Rotation of Neptune

SEVERAL circumstances delayed my observation of the planet Neptune this autumn until November 24. On that and the two following nights the light of Neptune was compared with the light of the star B.A.C. 1072; and, assuming that the light of the star was steady, that of Neptune was found to undergo apparently regular variations, but much smaller than they were last year.

The observations were combined in the following manner:—The magnitude, m, at any time, t, was assumed equal to

$$m_o + k \sin n (t - t_o),$$

where m_o was the mean magnitude at the time t_o, k one-half the variation between maximum and minimum, and n equal to $\frac{360^\circ}{7·92}$, or 45°·45, according to the observations of Neptune last year, which gave 7·92 h. as the rotation-period. Subtracting m', the unknown magnitude of the comparison star, which is, however, of about the seventh magnitude, we have

$$m - m' = m_o - m' + k \sin n (t - t_o);$$

and by assuming approximate values, by introducing corrections, and by solving the 11 equations corresponding to the 11 observations by the method of least squares, it was found that

$$m_o - m' = 0·86$$
$$k = 0·19$$
$$t_o = \text{Nov. 24d. 13·01h. G.M.T.}$$

The preceding epoch of maximum will be found by subtracting 1·98h.; and similarly the following epoch of minimum will be found by adding 1·98h.

Now these observations were made without special care, and consequently the probable errors were larger than they should be in comparison with the small variation; but on the night of November 29 every care was taken to obtain accuracy in the photometric measures, and the following results were obtained:—

$$m_o - m' = 0·82$$
$$k = 0·20$$
$$t_o = \text{Nov. 29d. 11·72h. G.M.T.}$$

The following is the comparison of observation and computation:—

Kempshot M.T. 1884 Nov. 29 h. m.	Diff. mag. ($m - m'$) Obs.	Comp.	o − C.
7 10	0·91	0·92	−0·01
8 26	1·03	1·02	+0·01
10 5	0·88	0·88	0·00
12 7	0·64	0·63	+0·01

It should perhaps be added that Kempshot is 5·19h. west of Greenwich.

By comparing the epoch on November 29 with the corresponding epoch on November 24, we find that 15 rotation-periods occupy 118·71h., so that each rotation-period is 7·914h., which may be considered identical with the period found last year. MAXWELL HALL

Jamaica, December 1, 1884

Peculiar Ice-Forms

CIRCUMSTANCES have prevented my replying earlier to Dr. Rae's letter in NATURE of November 27 (p. 81). The situation of the ice described in my letter of November 6 (p. 5) precludes the possibility of its having been a remainder from last winter's snow, since it was only some fifteen hundred feet above the valley of Chamounix, and exposed during the summer months to daily sunshine. In fact, the mid-day sun only just failed to reach it on the 17th of October.

In the *Neues Jahrbuch für Mineralogie* for 1877 (referred to by Dr. Wetterhan of Freiburg in NATURE, vol. xxi. p. 396) is an article by Dr. G. A. Koch giving an elaborate description and discussion of a very similar ice-structure, formed under very similar circumstances, which he observed on October 18, 1875, near St. Anton in the Arlberg. He also quotes other cases observed on the Wormserjoch in the Tyrol, and by Prof. Doenitz

in Japan. In all these, as well as in the case of the hills near Freiburg mentioned by Dr. Wetterhan, the soil appears to be a porous detritus with a hard substratum. At St. Anton, as at Chamounix, the hill-side sloped at an angle of about 50°, with a northern aspect, and in both cases and in Japan the phenomenon occurred in the autumn, a season often characterised, especially at high elevations, by cold nights and genial days. Dr. Koch calls it "*sonderbar*" and "*ganz eigenthümlich*," and it is plainly not of common occurrence.

Dr. Koch's explanation of the phenomenon is virtually the same as had occurred to me, except that both he and Dr. Wetterhan appear to consider that the water was derived by absorption from a moist atmosphere. In none of the descriptions, however, is there any mention of what was one of the most striking features of the ice which I tried to describe, viz. its division into distinct layers, each layer being of uniform depth; and this, showing as it does that the crystallisation was interrupted, and not continuous, seems to make it more probable that the water was supplied from below. The cylindrical perforations were, no doubt, caused by the presence of pebbles or small lumps of earth too dense to allow the ice-crystals to penetrate them, and too heavy to be pushed up. The layer of dust on the surface was much thinner in my case than in Dr. Koch's, which was no doubt due to accidental difference in the soil.

A friend in the country tells me that on a bright winter's day two or three years ago he picked up a piece of a dead beech-branch which was covered with filamentous ice, such as is described by the Duke of Argyll and others in NATURE (vol. xxi. pp. 274, 302). He brought it home, and, having examined it, left it out in the sun, when the crystals of course soon vanished. Next morning, however, he was surprised to see that they had all reappeared as before. The water from the melting ice had again filled the pores of the wood, and again been extruded in the same crystalline form. Now, if the highest temperature to which they had been exposed during the day had been 32° F., and a fresh supply of water had been afforded from any source to the wood, then neither would the ice have melted nor the water frozen; until the temperature fell again at night, when a fresh formation of crystals would have taken place, which would have pushed up those previously existing, and the result would have been a formation similar to that described in my letter. It seems more probable, therefore, that the moistening took place from below, as I suggested.

Hampstead, December 20, 1884 B. WOODD SMITH

Lightning in the Tropics

MY experience confirms the remarks of Dr. Von Danckelman in NATURE (p. 127) respecting the little damage done by lightning in tropical climates.

In the plains of India at the commencement of the monsoon, storms occur in which the lightning runs like snakes all over the sky at the rate of three or four flashes in a second, and the thunder roars without a break for, frequently, one or two hours at a time. During twelve years' residence in India I heard of only two human beings and, I think, three buildings being struck, although in parts of Lower Bengal the population amounts to more than 600 to the square mile. I always attributed the scarcity of accidents to the great depth of the stratum of heated air next the ground keeping the clouds at such a height that most of the flashes pass from cloud to cloud, and very few reach the earth. This idea is supported by the fact that in the Himalayas, at 6000 feet or more above the sea, buildings and trees are frequently struck. I have seen more than a dozen pine-trees which had been injured by lightning on the top of one mountain between 8000 and 9000 feet high. In the British Islands thunderstorms are said to be more dangerous in winter than in summer, and such a fact, if true, can be explained by the very thin stratum of air then intervening between the clouds and earth. J. J. MEYRICK

London, December 19, 1884

An Unnoticed Factor in Evolution

I AM surprised that the letter of Mr. Catchpool in NATURE (vol. xxxi. p. 4) has remained unnoticed by your correspondents. His hypothesis that mutual sterility may be the *cause*, not the *result*, of specific divergence, is, I think, quite in accordance with many observed facts. The buffalo and the ox, the sheep and the goat, have lived for ages side by side without, as far as I am aware, a hybrid between either of them having been produced. Mule or hinny hybrids between the horse and the ass are obtained easily, but the offspring is rarely fertile, so rare, that the British Consul at Granada told me, when I was there, that he had never known of a case, although in Spain mules exist in thousands. Amongst bovine animals many species produce hybrids which are apparently perfectly fertile; those between the Indian ox and the gayal, species of different genera, *Bos* and *Bibos*, are common, and their fertility is shown by the existence of numerous intermediate hybrids. There is living at the Zoological Gardens at the present time, a hybrid between the Indian ox, the gayal, and the bison, and, by her side, a hybrid between herself and a bison. The offspring of the cross between many species of ducks are perfectly fertile. This I have repeatedly seen in the case of the hybrids between the tufted duck and the pochard. I think there is another *unnoticed factor in evolution*. The scent of animals plays an important part in their sexual relationships, and "sports" in this respect are as likely to occur as in the organs of the body; thus the peculiar odours of the sheep and the goat may be mutually repulsive. J. JENNER WEIR

Chirbury, Beckenham, Kent, December 15, 1884

A Large Meteor

A MAGNIFICENT meteor was observed here last night. Its path lay from the west of σ Hydræ towards the west of η Monocerotis. Its head could not exactly be said to explode but broke up and extended suddenly considerably along its course, emitting a deep red and bluish white light, the latter of a most extraordinary brightness, for a moment quite sufficient to allow print to be discerned. It disappeared very near 11h. 19m. 6s. M.T. Dublin, and left a bluish white trace behind it, which could still with certainty be perceived seventeen minutes after the meteor had disappeared. OTTO BOEDDICKER

Birr Castle Observatory, December 23, 1884

THE FORMATION OF THE SOLAR SYSTEM[1]

THE aspect of the heavens, the appearance of the planets, do not give us the least idea of the solar system. In order to understand it well, we must in imagination quit our world altogether, and remove ourselves to a distance, so as to embrace in one glance the little system of which so ordinary a star as our sun occupies the centre.

Around the sun there move eight primary planets at very unequal distances. Of these planets six have satellites; that is to say, they in their turn are centres of little systems reproducing the solar system in miniature. Thus the Earth has a satellite, the moon; Mars has two, Jupiter four, Saturn eight, Uranus four, and Neptune, the most distant, has one. A striking thing in this system, that which makes it unique, is that the sun turns on its own axis from right to left, and all the planets without exception revolve around it in the same direction, almost in the same plane, that of the rotation of the sun, and describe orbits very nearly circular.

Would not one say that a vast gyratory movement animates all these bodies, and that the secondary systems of the Earth, Mars, Jupiter, &c., are little whirlpools moving in the primary one? Such was the idea of Descartes. If the solar system does not actually constitute a whirlpool, it was originally formed by a movement of this nature in the nebula which gave it birth.

The sky exhibits here and there a large number of gigantic masses of extremely rarefied matter, like the mists of chaos, without shape, having undergone only that degree of condensation necessary to create a feeble light. We require usually a powerful telescope to distinguish them, and then we can see them by thousands in the heavens; these are *nebulæ*.

When you visit an observatory under the escort of an astronomer whom you know, tell him several days beforehand that what you wish is not to gaze at the moon, or the planets and their satellites, or the fixed stars, double

[1] Translation of an article by M. Faye in a recent number of *L'Astronomie*.

or treble, white or coloured, but only to examine the nebulæ of various degrees of condensation. Your wishes being thus indicated, the astronomer will point out to you the most characteristic objects, he will calculate their exact positions, will prepare his most powerful telescope, and then you will be able to make an interesting journey into space.

The nebula of Orion has not a clearly defined form: one region more brilliant than the rest can be distinguished, where the condensation of the chaotic matter is rather far advanced. In all other parts the light is feeble, and one can detect long streamers of matter of which it is impossible to predict the action.

The nebula of Andromeda is one of the most remarkable objects in the heavens. It has an almost geometrical form, and in the centre it exhibits a most distinct condensation.

The nebula of Leo presents nebulous rings in course of formation.

Finally, the curious double nebulæ of Virgo, Aquarius, &c., are evidently very near their ultimate transformation into stars.

It would be easy to multiply the intermediate stages, and to show, for example, some nebulous stars presenting the penultimate phase of this series of transformations, which commences with a feebly luminous mist without shape, and finally arrives at one or many suns variously connected. Needless to say, we are not present at these transformations, but we are like the botanist who in the forest studies the trees in their different degrees of development. Thus the creation of the universe is carried on, so to speak, under our eyes. In the beginning nebulæ separated out from a universal chaos; in the end, incandescent stars, or other globes so small that we cannot see them, because their formation has produced so little heat that their light is already extinct.

Let us imagine that, owing to some cause of which we shall presently speak, the spirals of a whirling nebula are transformed into nebulous concentric rings, governed by a common movement of rotation. In reality there exist in the heavens objects of this description: for example, the annular nebula in Lyra.

If such as these are rare, it is because they usually do not possess great stability. It is only a transitional form. In reality, in virtue of the differences of linear speed which predominate there, and because of the mutual attraction of their parts, the least cause will lead to eddyings, which, being obliged to follow somewhat the same road with rather different speed, reunite and are lost in a single nebulous mass, where, little by little, all the material of the rings will be absorbed. This nebulous mass, excited by a rotation in the same direction as that of the ring, will in its turn give birth to a planet surrounded by satellites revolving in the same direction and in the same plane.

We have a series of nebulous rings, some of which show the eddying condensation which ends in a mass of planets. At the same time the enormous quantity of material which in the midst of the original nebulæ was not used up in the rings, has little by little reunited in the middle, very slowly at first, but afterwards very quickly, giving rise to a central globe, a Sun, turning on its own axis in the same direction and in the same plane as the planets.

We thus see how a slow whirling movement, more or less indistinct, would be able to be governed so far as to give rise to these circular rings, all of them concentric and situated in the same plane.

It is necessary and sufficient for this theory that the solar nebula has been, in the first instance, spherical and homogeneous. In such a mass of matter the internal gravity resulting from the attraction of all the molecules varies in a direct ratio with the distance from the centre. The particles or the small bodies which move in such a medium, where the rarity is inconceivable, necessarily describe ellipses or circles round the centre *in the same time*, whatever may be their distance from that centre. Thenceforth the existence of rings rotating in one piece, with the same movement, is quite compatible with this condition of gravity, and if a whirling motion has pre-existed, some of these spirals, which are not so very different from circles, will have little by little become transformed into the rings previously described, owing to the small amount of resistance at the centre.

Let us take a step further. In virtue of the force of attraction these rings tend generally to break up and to form a nebulous spherical mass, which in the end contains all the material of the ring. Now these secondary nebulæ must necessarily be endowed with the same direction of rotation as that of the rings. Phenomena exactly like those of the primary nebula will then take place; that is to say, they will resolve themselves into concentric rings, then into a central globe. In their turn, the rings will be condensed into other very small balls—satellites revolving round each planet, always in the same direction, whilst the planet will turn on its own axis exactly in the direction and in the plane of these secondary rings.

It is thus that these things have come about. By a lucky chance some rings of the little secondary system of Saturn have escaped destruction, and have not been formed into satellites. I attribute their existence to the extreme thinness of these rings and to their rapid rotation.

We should now have finished the explanation of the solar system if this system did not offer a striking peculiarity, apparently in complete contradiction with what has preceded. Of the eight large planets revolving round the sun six have satellites, and thus form secondary worlds, exact representations of the solar world which includes them. After what I have said, all the rotations and revolutions ought to be in the same direction, and, what is more, in the "direct" direction. Now in the secondary worlds of the two planets furthest off—those of Uranus and Neptune—the rotations and revolutions of the satellites are in the opposite direction, that is to say, *retrograde*.

Must we believe that the theory that I have put before you is false? It is not false, but it is incomplete. And here we come to one of the most interesting points in the history of science. Newton and Laplace believed that all the rotations, all the revolutions must be in the same direction. Laplace went further, and applied to this question the theory of probabilities. In working on the planets and satellites as known in his day, his analysis showed that, if a new planet or satellite was discovered, the chances were tens of thousands to one that the revolution of this or that satellite, or the rotation of this or that planet, would be direct, like all the others, and he added that this probability is much greater than that of historical events which we accept with the utmost confidence. The study of the satellites of Uranus, and the discovery of the system of Neptune, however, has at once destroyed this probability, and the celebrated cosmogony of Laplace. This in fact by an ingenious process derives all the planets from the sun, but it can only give to the planets and satellites relations and revolutions in the same direction from one end of the solar system to the other, whilst in fact they are direct in the first half and retrograde in the second.

Let us actually complete our theory. In the primitive nebula, homogeneous and spherical, where the presence of rings revolving round the centre ought not to alter anything in the law of internal gravity, we have seen that this gravity varies in a direct ratio with distance from the centre. But, later, the sun was formed by the reunion of all the matter not wanted for these rings; this has produced an empty space around it. Therefore the law of gravitation in the interior of the system thus modified became quite different. Under the action of the preponderating mass of the sun (that of the rings was not

the 700th part of it) the internal gravity has varied, not in the direct ratio of the distance, but in the inverse ratio of the square of the distance from the centre, and that is the state of things to-day.

In this last case the method of rotation of a ring of diffused matter entirely changes. Let us hasten to say that this alteration does not hinder the ring from existing. Saturn is the proof of it.

But whilst, according to the law of gravity first in operation, the linear velocity of revolution in these rings increased with the distance; according to the second, this velocity on the contrary decreased in the ratio of the square root of this distance.

In the first case, when the ring will have degenerated into a secondary system, that is to say, into a nebula with exterior rings, and finally into a planet with its satellites, the rotation of the planet and the revolution of the satellites will be in the same direction as the movement of the original ring, that is to say, the motion will be "direct." In the second case the secondary system thus formed will be retrograde.[1]

What are we to conclude from this? It is evident that the planets from Mercury to Saturn, included in the central region, were formed according to the first law, when the sun did not yet exist or had not acquired a preponderating mass; and that the planets included in the exterior region, which was by far the larger, were formed when the sun had already come into existence.

If then it should be discovered that Venus had a satellite, its motion would be direct. If a planet were discovered outside Neptune, its rotation and that of its satellites would be retrograde. Here we have at last arrived at a conclusion of the greatest interest: the earth is much older than the sun. If it were otherwise—if, as Laplace would have said, its formation had been long after that of the sun—all would have been changed in the aspect of the skies: the stars would rise in the west and set in the east; the moon would have a retrograde motion, like the satellites of Uranus and Neptune. Let us add that at that time it was further from the centre than it is now; for when the matter which was outside the terrestrial orbit had passed over it to be reunited in the interior to orm the sun, as the attraction of the latter gradually preponderated, the revolution of all the planets within the orbit of Uranus was accelerated. These planets approached the sun at the same time that their satellites receded from them.

Finally, the actual state was attained, with the stability which characterises it, when the mass of the sun, having become enormous, could attract nothing more from the original nebulous matter, and had at last created around itself an empty space.

The universe has grown out of chaos, that is to say, out of a mass of matter excessively rare, without shape, occupying a vast space and moving in various directions, in virtue of which this chaotic matter was divided into separate masses. It is by the progressive condensation of these masses of chaotic matter towards certain centres of attraction that the innumerable stars have been formed. Their incandescence comes from the heat developed during the act of their formation. The amount of their heat is limited; they will end by being extinguished.

Amongst all the systems, which are infinitely varied, which have grown out of the condensation of this primary chaos, the solar system may be regarded as a very special case. The primary nebula which gave birth to it was spherical and homogeneous. In separating itself from other portions it had carried with it traces of a slow whirling movement. These motions were soon regulated, thanks to that particular law of internal gravitation resulting from its shape and its homogeneousness. Nebulous rings were thus formed in the same plane long before the appearance of a central condensation. They gave birth to nebulous masses also moving in this plane, in the same direction and in circular orbits, around their common centre.

The secondary systems formed in the same way into these partial nebulæ can be definitely separated into two categories: those which preceded the formation of the sun, revolving on their own axes in "direct" directions; whilst the secondary systems, the furthest off, formed after the sun, revolve in a retrograde direction. These strange phenomena which are presented by our solar system, are doubtless, by a rare exception in the universe, only the natural consequences of the initial conditions and of the laws of mechanics.

[1] Laplace believed that in the nebulous rings derived from the sun (according to his hypothesis)—rings which will have belonged to the second case as they would be exterior to the sun—the friction of different concentric layers would have had the same effect as what occurs in the atmosphere of a planet, which ends in moving altogether with the central globe. In this way the ring will have taken on the movement of the first form, that is to say a rotation; its outer marginal layers will have had a greater linear speed than that of the layers nearer the centre, and its condensation will have given place to satellites with direct motion It is easy to show that this manner of looking is not altogether exact (in proof of this we can point to the rings of Saturn). The layers of an atmosphere press on one another; further, the external layers only resist by their inertia to the communication of the rotatory movement which tends to establish itself between the central globe and the extreme layers of its atmosphere. But, in a nebulous ring, the concentric layers do not press one on the other as in an atmosphere, for each one moves in virtue of its own speed at its distance from the sun. Further, the retardation of the layers situated near the extreme edge as compared with the internal layers is not due to their inertia, but to the laws of their motion. If then the solar system has been created in accordance with the hypothesis of our great geometrician, all the planets would have revolved round the sun in the direct direction, but their rotations and their satellites would be retrograde.

BERZELIUS AND WÖHLER

THE "Jugenderinnerungen eines Chemikers," which the late Prof. Wöhler contributed to the *Journal* of the German Chemical Society in 1875, contains a delightful sketch of the personal relations in which the great German chemist stood to his illustrious master; and Dr. Hofmann's account of Wöhler's life and works, published in the same journal for 1882, serves to fill in the details of the picture. The story of Wöhler's visit to Stockholm, of his intercourse with Berzelius, and of the influence which it exerted on the development of his scientific life. are now well known to chemists.

All the papers left by Berzelius are in the possession of the Swedish Academy of Sciences at Stockholm, and among them are the letters which he received from Wöhler. Some time before his death Wöhler presented his letters from Berzelius to the Academy with the injunction that they were not to be published before the close of the present century. Some extracts from the letters of Wöhler, on the publication of which no restriction was made, have recently been given to the world by Dr. Edv. Hjelt of Helsingfors,[1] from which we may gather some notion of the wealth of material which will be at the disposal of him whose lot it is to write the personal history of the chemistry of this century.

Wöhler's letters to Berzelius extend from 1823 to 1846, and are 230 in number. In all probability the correspondence was continued up to the time of Berzelius's death in 1848, but the letters of the last two years are not contained in the collection. The greater portion of the letters from Wöhler consist of accounts of his investigations, of discussions of scientific questions, of critical opinions on new works and new theories, and of *memorabilia* of the chemists of the time. Many of the letters have reference to the translation of Berzelius's "Jahresberichten" and his large "Manual of Chemistry" into German. Now and again we have a gossiping letter, rich in a quiet humour, and occasionally illustrated by quaint characteristic sketches. First in order of time comes Wöhler's application for a place in Berzelius's laboratory, dated July 17, 1823, and next is his grateful acknowledg-

[1] "Bruchstücke aus den Briefen F. Wöhlers an J. J. Berzelius." Herausgegeben von Dr. Edv Hjelt. (Berlin: Robert Oppenheim, 1884.)

ment of Berzelius's prompt and cordial acquiescence in his wish :—

"Wie sehr freue ich mich auf diesen Winter," he writes, "wo ich mich einmal so ganz *con amore* der Chemie ergeben kann, ohne die Zeit in andere, mehr oder weniger fremdartige, nicht so ansprechende Studien theilen zu müssen."

Wöhler remained about a year in Stockholm ; he was wont to speak of his stay with Berzelius as "eine nicht zu berechnende Wohlthat." As to Berzelius, no one of his pupils lay nearer to his heart than Wöhler.

In the selection of his letters it is obvious that Dr. Hjelt has been loyally mindful of the condition imposed by Wöhler. Doubtless much of the correspondence had reference to letters of Berzelius, and therefore to matters which the world can only know of in the twentieth century. The letters which we are permitted to see have, however, a great interest from the light they shed on the writer's character, and from the accounts they give of the origin of those fruitful discoveries which have made the names of Liebig and Wöhler inseparable. How that partnership originated need not be told again. It seems, however, that in more than one letter Berzelius had expressed his conviction that Wöhler's share in the work was but imperfectly recognised. That Wöhler was, in fact, the mainspring of much of their labour is now known, but he himself writes, "What matters it, however, when the business in hand profits thereby, and such is assuredly the case. We two, Liebig and I, have dissimilar kinds of talent ; each, when in concert, strengthens the other. No one recognises this more fully than Liebig himself, and no one does me greater justice for my share of our common work than he."

In the following letter we get a glimpse of Liebig's mode of work :—

"The days which I spend with Liebig slip by like hours, and I count them as among my happiest. His apparatus for organic work seems to me most excellent, and he is a master, of almost pedantic exactitude, of organic analysis. But in all that relates to inorganic analysis, as, for example, filtration, use of lamps, &c., one sees throughout the imperfect French methods. He uses neither a filter-stand, nor good filters, nor usually a lamp. . . ."

Liebig's earnestness, and restless energy, and fiery impulsiveness, brought him unfortunately into frequent conflict with his contemporaries. It was almost inevitable that he and Berzelius should sooner or later come into collision. Nothing in the letters is more charming than the manner in which Wöhler sought to maintain peace between his friends, constantly seeking to excuse the one to the other. He writes of Liebig to Berzelius :—

"He is thoroughly upright, honourable, and generous, but passionate and inconsiderate."

At another time he wrote :—"He who does not know him intimately would hardly realise that at bottom he is one of the most good-natured and best fellows in the world."

It is somewhat remarkable that Wöhler, although trained in a school of which analysis was made the predominant characteristic, should have failed to discover any new elementary body, even whilst constantly occupied with the examination of rare minerals. We all remember the story of Vanadis and the "Schalk" Wöhler, who failed to woo her with proper assiduity. It now appears that the element thorium also slipped through his fingers unperceived. "Also," he wrote, "eine analoge Geschichte mit dem Gotte Thor, wie mit dem Göttin Vanadis." Wöhler's triumphs were won in organic chemistry. "The organic chemistry of to-day," he wrote in 1835, "is enough to make one quite dazed. It is like the primeval forest of the tropics, full of the most curious things ; an immense thicket without exit and without end."

One of the most historically interesting letters of the series is that in which he communicates to Berzelius his memorable discovery of the synthesis of urea—"ohne dazu Nieren oder überhaupt ein Thier, sei es Mensch oder Hund, nöthig zu haben." It now appears that the transformation of ammonium cyanate into a body which gave no reactions for either cyanic acid or ammonia was observed by Wöhler whilst in Stockholm, but the significance of the change escaped him for the time. How, almost accidentally, he returned to the subject, and how by three or four decisive experiments he establishes the nature of the new body, is shown in the letter. Berzelius had not then invented the word "isomerism." For a time, indeed, his conservatism rebelled against the conception. Wöhler's words in reference to urea—"This is therefore an incontestable example that two absolutely dissimilar bodies can contain the same proportion of the same elements, and that it is merely a difference in the mode of combination which brings about the dissimilarity in their properties"—must have paved the way for Berzelius's conversion. How strange, too, the following sentence must have sounded in 1828 ! "May not this artificial formation of urea be regarded as an example of the production of an organic substance from inorganic materials ?"

The witty and sarcastic letter which appeared in the *Annalen* for 1840, in which "S. C. H. Windler, aus Paris," sought to ridicule the substitution theory of Dumas, was at the time generally ascribed to Liebig, but we know now that it was written by Wöhler for the amusement of Liebig, "ohne dass ich aber im Entferntesten daran dachte dass er so toll sein wurde ihn in den Annalen Abdrucken zu lassen."

Wöhler not unfrequently amused himself and his friends with *allotria* of this kind. The well-known flash which attends the crystallisation of plate sulphate of potash was on one occasion thus explained :—"Die Lichtfunken bei krystallisirenden Salzen hängen mit einer gleichzeitig im Krystall vor sich gehenden isomerischen Umsetzung der Bestandtheile zusammen, z. B. ein krystallisirtes Schwefelsaures Kali könnte eigentlich unter gewissen Umständen KSO_4 or KO_3SO geworden sein. Nun aber arrangiren sich plötzlich die Atome zu $KOSO_3$ und dabei blitzt es, weil in dem einem Falle Kalium zu Kali, und in dem anderen unterschweflige Säure to Schwefelsäure verbrennt. Ich will diese Idee an Kastner verschenken."

Berzelius died on August 7, 1848, after a long illness. Almost his last words had reference to Wöhler. Wöhler always spoke of their friendship as one of the brightest memories of his life, and we are told that even to the last the eyes of the old man would glisten when the name of Berzelius crossed his lips.

T. E. THORPE

AMERICAN STORM WARNINGS

THE Meteorological Office, through the co-operation of the Chief Signal Officer of the United States War Department, has commenced to issue notices of the current Atlantic weather, and it so happens at the very commencement of the system that the frequent occurrence of storms in the vicinity of the British Islands, as well as out in the open Atlantic, has afforded a favourable opportunity for testing the value of this extension of our weather knowledge. As a specimen showing the nature of the information, we append a copy of the notice issued on December 19 :—

"The Chief Signal Officer at Washington, U.S., reports that, at 4 a.m. on the 16th inst., in lat. 42° N., long. 60° W., with the barometer at 29·4 inches, there was a fresh gale from south, veering to west."

A subsequent notice was issued, showing that the same storm was met with eight hours later, and had advanced rapidly to the east-north-eastwards. It appears highly probable that the disturbance in question was the same

as that which passed swiftly across our islands during the night of the 19th to 20th, and had its centre off Yarmouth at 8 a.m. on the 20th, having travelled about 2600 miles in four days and four hours, or at the rate of twenty-six miles an hour. This rate is somewhat high for an average extending over so long a period, but it is in accordance with former experience for an isolated storm-centre, and is fully supported by the high rate of progress the storm had when traversing England. The barometrical gradients in the rear of this storm were very steep, and the difference of pressure was accompanied by a heavy gale on the 20th over the whole of the southern portion of our islands.

We are glad to see that the Meteorological Council are taking steps to ascertain the atmospheric changes which are going on over the Atlantic, since the weather of that ocean has such an important bearing upon that of the British Islands. It is now no longer a matter of speculation as to where the weather comes from which strikes our coasts, but the synchronous charts which have been prepared by the Meteorological Office, both under Admiral FitzRoy and the subsequent governing body, as well as by Leverrier, Hoffmeyer, Neumayer, and the Signal Service of the United States, amply prove that in the north temperate zone of the Atlantic, at least, there is a regular movement of the weather-systems from west to east, or, more strictly, from some point between west and south-west towards east and north-east. These weather-systems not only embrace storm areas, but, to a very large extent, all the ordinary weather changes. It is our intention here, however, to limit our remarks to the question of storms and unsettled weather, as not only being of primary importance, but the conditions with such weather will, although of a more pronounced type, illustrate in a very great measure almost all other meteorological changes.

Probably the enterprising proprietors of the *New York Herald* have done more of late years than all other authorities put together to popularise the fact that our weather changes traverse the Atlantic, but the notion, if nothing more, of the easterly translation was in existence 180 years ago, for Daniel De Foe, in his discussion of the great storm of 1703, inclines to the opinion that it came from America, since, as he says, "they felt upon that coast an unusual tempest a few days before the fatal 27th of November."

The United States Signal Service has for several years past published monthly track charts of all storm-centres in the North Atlantic, and the most cursory examination of these is sufficient to prove that very valuable information might be transmitted to Europe from America with respect to the weather experienced by trans-Atlantic steamers on their outward passage. Prof. Loomis, who has devoted considerable attention to the tracks of Atlantic storms, has calculated the average velocity of storm-centres in the Atlantic Ocean to be fourteen miles an hour, and has shown the rate of progress to be less over the sea than over either America or Europe. Some other authorities have given rather a higher rate of progress than Prof. Loomis, but when a large number of instances is taken it will not be found that the average rate exceeds twenty miles an hour, and probably this rate is the safest that our present knowledge of the subject will allow. The charts of the United States Signal Service for 1879, which exhibit the tracks of ninety-two distinct storm-centres in the Atlantic, show the average rate of progress of all these storms to be eighteen miles an hour. From this it will be seen that, with the speed now attained by many of our principal steam-vessels engaged in the trans-Atlantic trade, if a storm is met anywhere to the westward of the mid-Atlantic, a vessel can, on arrival at a port in the United States, transmit timely notice to Europe that a storm has been experienced, and such notice will serve as a caution to our home authorities to be on the alert for any evidence of our outlying stations indicating the approach of the storm until its subsequent arrival, or until ultimate proof is obtained that it will not strike our shores. The fact that a storm is blowing out in the Atlantic will also probably be valued by commanders of vessels who are leaving port bound westwards.

The Atlantic gales differ so materially from each other in their character that any information which will convey the nature of an impending storm, either to vessels outward bound or to those engaged on our coasts, will be of the highest importance. It sometimes happens that the whole of the northern part of the Atlantic is taken up with one vast disturbance, the wind blowing with the force of a gale over an area having a diameter of upwards of 1500 miles, and occasionally extending from the coast of America to Europe. On the other hand, several disturbances may exist at one time between the two continents, and in this case a vessel is no sooner out of one storm than she enters the margin of another, and these conditions may last throughout her passage. This will be readily seen from the synchronous weather work already referred to; and, if further proof is wanted, it is to be found in the frequency with which storm-centres pass either over our islands or in their immediate vicinity, and in sufficient proximity to influence our winds and weather, if not near enough to give gale force to the wind.

The British Islands are probably less favourably situated for the successful issuing of storm warnings to our own coasts than any other country, since they are in the direct path of the Atlantic storms, and they have not the advantage of any stations within reasonable distance to the westward beyond their limits by which they may be warned, so that it often happens that a storm is almost upon us before its approach is foreseen. An attempt was made some years ago to moor a vessel at the entrance to the English Channel and to connect it by a telegraph cable with our coast, but the attempt was a failure, and experience has shown that the step now taken by the Meteorological Office to obtain Atlantic weather information is the only one which promises success.

THE ACTINIÆ[1]

THIS is a work which contains far more than it promises. Though commenced with the intention of describing only the Actinians (sea-anemones) of the Bay of Naples, it has extended until it includes all the species known; and although at first sight it seems nothing more than an ordinary systematist's manual—a dry dictionary for the specialist—it turns out on closer examination to have a clearly-marked individuality of its own. In its preface the author remarks, with a tinge of dry humour which here and there ripples the clear precision of his style, that in these days of papers full of histological detail, or rich with plates of caryolitic figures, embryological sections, or genealogical trees, his big book, apparently so purely systematic, may at first excite among his scientific brethren a smile of compassion, if not indeed a word of contempt. Far, however, from renouncing his intellectual birthright of wider scientific aims, he claims with justifiable pride to have produced (and at a self-denying outlay of time and toil not excelled by that of any histological investigation) no mere arid catalogue of genera and species, but a summary of the whole past of actinology, and a new starting-point for the future. He promises, too, a second volume, in which the anatomy, histology, and development, the physiology, distribution, and phylogeny, will be discussed, and no doubt as exhaustively.

The bibliography alone is well worth notice, for its scholarly precision and thoroughness furnish a royal road

[1] "Fauna und Flora des Golfes von Neapel. Le Attinie." Monografia del Dr. Angelo Andres. Vol I. Bibliografia, Introduzione, e Specigrafia. (Leipzig: Wilhelm Engelmann, 1884.)

to their next investigator, for whose benefit also the most elaborate system of general and special indexes is provided. The history of actinological progress is critically exposed, and even the humblest species-maker scrupulously receives his tiny share of immortality, while the veriest trifles of etymology, popular nomenclature, or culinary use, are not forgotten.

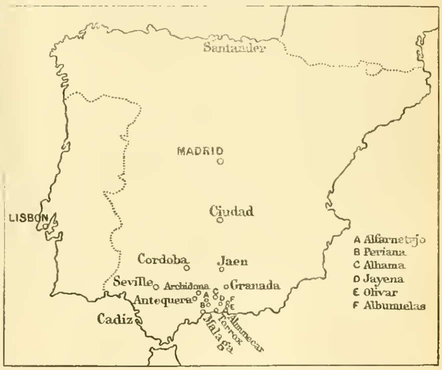
Far more important, however, is the clear schematic account of actinian anatomy, with a recast morphological nomenclature, and thereupon follows the plan of the monograph, where our author briefly outlines the general view of biology and of the relations of its sub-sciences which dominate the work. This agrees largely with that usually adopted in this country (cf. Prof. Huxley's article, "Biology," in the "Encyclopædia Britannica"), but differs from it in some important respects, notably in the separation of taxonomy into *Specigrafia* and *Sistematica*. Next follows a keen re-discussion of the conception of *species*, and the limits of *genus* and *variety*. The last he proposes admitting as a rule, and then by giving variety an analytic and genus a synthetic aim, and making both changeable as systematists find expedient, he hopes to keep the conception of species near a more constant average. After some useful remarks on nomenclature, the systematic detail is entered upon, and the known species (520 or more), with their endless varieties, described with exquisite minuteness. Numerous diagrams aid the work of identification, and the volume concludes with thirteen magnificent plates, which reflect the greatest credit alike upon the author's pencil and the care of his lithographers, Messrs. Werner and Winter. The classification differs so much from existing ones as almost to be new. Two new families, *Edwardsinæ* and *Stichodactylinæ*, are created; the *Ilyanthidæ* are almost abolished, the *Minyadinæ* wholly so.

If space permitted, one or two trifling criticisms might be offered, if only to accent the general praise; yet it is better to welcome the book unreservedly as a new sign of the scientific *renaissance* of Italy, and its author as henceforth one of its leaders, who has learned philosophic breadth from the "Origin of Species" without losing the detailed accuracy of the "Monograph of the Cirripedia."

A word finally as to the splendid series of monographs to which this belongs, and which, together with the *Challenger* volumes, mark an epoch in biology. Is it not lamentable that such works—which, if not yet indeed. in time-honoured phrase, "books which no gentleman's library should be without," are certainly needed in every public library, and which even no local natural history society can afford to be without—should be limited to an impression of, after all, only a few hundred copies by the apathy or ignorance of the scientific public? P. G.

THE EARTHQUAKE IN SPAIN

AN earthquake of wide extent and unusual violence took place on Christmas night in the southern provinces of Spain and in the neighbourhood of Madrid. The accompanying map may give some idea of its extent. As many of the towns and villages of Granada, Malaga, and Andalusia are unconnected with the capital by telegraph, the full extent of the damage is not yet known, but enough information has been received to mark the present as among the most destructive earthquakes of recent years. No precise observations as to time or direction have yet reached this country; and the officials at the Madrid Meteorological Observatory are reported to have made no observations at all, for there were no funds to purchase instruments for such a purpose. Madrid itself was within the disturbed area, but it was probably on its extreme north edge, for the effects of the shocks there were slight, and were confined to the rattling of windows, the ringing of bells, and the like. But in the three southern provinces the destruction was great and widespread, involving in many cases considerable loss of life. There were several shocks, overthrowing whole villages and burying the inhabitants in the ruins. In Arenas del Rey 40 persons were killed, in Albuequeros 150, in Olivar 10, and in Cajar 12, and similar numbers in many of the towns and villages of the three provinces. The number of killed on the whole is put down in Madrid, from the reports of the local officials, at more than 1000. Even in large cities such as Granada, Malaga, Jaen, and Seville great damage was done, and much excitement prevailed. The inhabitants encamped in the open air through fear of fresh shocks. At Granada the front of the Cathedral was seriously injured, but the Alhambra was untouched. There is much discrepancy in the reports as to the duration of the earthquake: some village authorities have reported ten distinct shocks, while in other cases it is stated that there were seismic disturbances intermittently on the 26th, 27th, and 28th, the three days succeeding the great earthquake. This is especially reported from Jaen, where there should be ample means of corroborating the statement. At Cadiz a panic occured in the theatre; in Malaga the Cervantes Theatre was much injured. It is noticeable that a sharp fall of the barometer was noticed all over the south of



Spain in the afternoon before the earthquake, and that there have since been frequent fluctuations. There is some doubt whether the number of persons who have lost their lives will not far exceed a thousand, inasmuch as the reports, as they grow more detailed, instead of diminishing, largely increase the original estimates. At Periana, in Malaga, a landslip on a mountain in the neighbourhood destroyed a church and 750 houses, from the ruins of which the dead and injured were being taken: similarly at Loja half the houses were overwhelmed. The town of Alhama in Andalusia is reported to have been completely destroyed, with 300 persons. A report is published with regard to Albunuelas, stating that 900 persons are believed to have been killed under the houses thrown down by the earthquake. This would be about one-half the population of the town. At Antequera the shocks have left three churches in a dangerous condition, and the inhabitants are camping in the fields; the Cathedral at Seville, especially the Giralda tower, is much damaged; at Granada the richer classes are living in their carriages, which are stationed on the public promenade; the others camp out in the squares and open spaces; at Cordova the inabitants are flying from the town. The loss in the town of Malaga is put down at 100,000*l.*, 227 buildings being injured. It would appear that five distinct shocks took place in this town on Christmas night, and three on the following morning. Five shocks on Friday and

Saturday are reported from Antequera, and nine from Archidona. That the disturbance has not yet ceased is shown by the report from Torrox that the shocks were renewed there on the morning of the 29th, shaking the foundation of the Town Hall, and causing cracks in the walls of other houses; while other violent shocks are reported from Malaga and Granada on the evening of the 30th, one at 7 and the other at 10 o'clock. In connection with these after-shocks, a report from Tarvis, in Carinthia, states that an earthquake was felt there on Sunday, which by the oscillation it caused cracked the walls of many houses. The Spanish earthquake was not felt in the north and north-western provinces. No precise information as to the times of the shocks at the various places has been received. At Xerez and Cadiz, according to one account, the first smart shocks occurred shortly before 9 o'clock, and other slighter shocks about midnight and 4 o'clock the next morning. At Ciudad Real no damage appears to have been done, beyond the alarm to the inhabitants, who passed the night in the open, fearing a recurrence of the shocks. At Velez Malaga and Malaga proper several shocks injured the theatre and the churches, the falling masonry killing several persons. The clocks are stated to have stopped in various parts of Andalusia at from ten to seven minutes before nine, which may therefore be taken as the time of the first shock.

We have received the following correspondence on the subject of the earthquake:—

Yesterday, 25th, at 8h. 53m. p.m., slight earthquake in Madrid: two distinct shocks in 3 to 5 seconds; house bells set ringing and lamps and other suspended objects swinging; the oscillations were almost due east and west, which gives north and south as the direction (rough) of seismic disturbance. This was evidently stronger in some parts of the town than others, as out here it produced no effect outside, whereas according to this morning's paper much alarm was produced in some streets by people rushing out of their houses. But earthquakes are very uncommon in Madrid, and this accounts sufficiently for the scare. There really was no particular cause for alarm. Official telegrams report shocks felt at about the same time in Cadiz, Malaga, Granada, and Cordova.

F. Gillman

Quintana, 26, Madrid, December 26, 1884

I have reason to believe that this commotion extended to England. On the night of December 25 I left my family quietly seated round the fire at 10 o'clock. Being in bed myself at about 10.20, I perceptibly felt a shock of earthquake such as I have often experienced in the vicinity of Naples, and I said to my wife, who came up shortly afterwards, "I have felt a distant shock of earthquake. if there is nothing moving downstairs," which from the distance of the offices there certainly was not. The motion, we learn, was from south to north, and the usual rate of movement corresponds well with the time of the occurrence—say 6 minutes to 9 at Madrid.

The Rookery, Ramsbury, Wilts — Alfred Batson

THE HABITS OF THE LIMPET

The following observations upon the habits of the common limpet (*Patella vulgata*) were made during last July at the Scottish Marine Station, Granton, Edinburgh. I am much indebted to Mr. John Murray, the manager of the Station, for kindly placing its resources at my disposal, and also to Mr. J. T. Cunningham, B.A., the director, for much kind advice and assistance.

The *Ark* is moored in the centre of a flooded quarry, upon whose faces large numbers of limpets are to be found. As parts of these faces are almost or quite vertical, it was easy to take a boat round and make observations during all states of the tide. The few that were made bear on the feeding and locality-sense of the form in question.

By far the larger number of limpets "roost" upon rocks whose only covering consists of minute green algæ and nullipores, together with numerous acorn barnacles. These last are seen to be of very unequal degrees of "cleanness," some being covered with vegetable growth, others quite white and bare. Those immediately surrounding a limpet or group of limpets are invariably free from algæ. As might have been anticipated, Patella is the cause of this freedom. At low tide anyone on the look-out can hear a quick, regular, rasping sound in all directions, and see numerous limpets slowly crawling about. Scrutiny of any particular individual shows that the rasping noise is caused by strokes of the radula, which speedily scrapes away the incrusting algæ. Whilst "on the feed" a limpet moves steadily on, pretty much in a straight line, and continually sweeps its elongated snout from side to side, feeling out probably suitable patches whereon to graze. When such a one is discovered, it is gradually licked quite clean. If the patch happens to be the surface of a moderate-sized barnacle, the circular lip is completely spread over it, almost tempting one to believe that the crustacean is about to be "sawn out." Such, however, is not the case, "house-cleaning" being the sole end in view. Indeed, limpets are often serviceable to one another by thus clearing away esculents growing upon their shells. To secure a dinner, a good deal of licking is requisite, and perhaps this habit may help to account for the inordinate length of the tongue-ribbon. Certainly it must be used up at a very great rate.

But this is not the only, though I believe the chief, way in which the limpet feeds. Those individuals which live near large sea-weeds, such as Fucus, feed extensively upon them, as their gnawed condition testifies. I can speak confidently in this matter, having caught more than one limpet in the act. The operation was as follows:—The edge of a thick flat part of the thallus was seized by the lip (as a traveller might commence on a colossal sandwich), and being, I suppose, held firmly by the upper jaw, a semicircular "bite" was gradually excavated by successive scrapes of the radula, the edges of the bite being bevelled on the under side. So far as my observations extended, limpets do not feed when covered by water, but always settle down firmly before the rising tide reaches them. The intervals between which any particular limpet feeds seem to be very irregular; but, as a rule, the largest limpets are apparently least fond of long fasts.

In regard to the second point, the locality-sense, great doubt seems to exist in the minds of naturalists as to whether limpets go back to the same place to roost. I believe the question was answered in the affirmative long since by a Mr. King, but, as far as is known to me, he did not publish any details of his observations, and this is my excuse for giving an outline of mine. Following a suggestion of Mr. Murray, I marked a number of limpets with white paint, and made corresponding marks near their "scars" with a view to "keeping my eye on them." As Dr. S. P. Woodward remarks, it seems probable from an *a priori* point of view, that limpets have a settled home, for they occupy scars, often sunk to a considerable depth, which *exactly* correspond to the outline of the shell. My observations, made on numerous specimens of various sizes, completely confirm Mr. King's opinion, and the method of marking rendered cases of "mistaken identity" quite out of the question. The greatest distance from its scar at which I noticed a marked limpet to be, was about three feet; yet this distance, though extremely rough, and covered with barnacles, was re-traversed without difficulty. The excursions from the roosting-places were made in any direction where food offered; so there were nothing like beaten tracks formed. But a limpet always returns home before the rising tide reaches it, and invariably

roosts with its snout pointing in the same direction. As might be expected, this direction is only constant for individuals. As the shape of the scar corresponds exactly with the shape of the shell, comfort, of course, could only be gained and a firm hold effected by limpets roosting permanently in the same direction on their scars.

The question now arises, What sense is employed by the limpet in finding its way back to its scar? The appreciation of locality displayed is certainly, for so simply-organised an animal, very keen. The sense of sight is evidently out of court, for an eye like the limpet's, consisting of no more than a sensitive cup, could do little if any more than distinguish between light of different degrees of intensity. The tentacles seemed at first sight to be extremely likely organs to use for the purpose, and to decide this I excised those of two marked individuals which were off their scars. One speedily found its way back; the other seemed confused by the operation for several days, but after that time was found on its scar. This shows a remarkable power of memory, unless the scar was found by accident, which is possible, as the individual was near home when the operation was performed. But even in that case the scar must almost certainly have been *remembered*. Thus, the tentacles do not seem to be the means by which home is returned to. The sense of smell then suggested itself, and it occurred to me that one reason why limpets kept on their scars when covered by the water was to prevent the "scent" of the track traversed from being washed off. With a view to determine this the space between a wandering limpet and its scar and the scar was carefully washed again and again with sea-water. In spite of this the limpet in question readily found its way back again. Further experiments are, however, needed on this head, for any ordinary washing would be very ineffective compared with the prolonged soaking the tide would effect in the case of a limpet (like the one just mentioned) living some distance below high-water mark. Still some limpets live so near this last that they are covered but a very short time, and yet these remain on their scars during that time. Hence I think some other motive probably induces them to remain firmly fixed to their scars when under water. Of course they can hold on best when so fixed, and this suggests the most likely reason for the habit, *i.e.* to avoid being washed off the rocks by the tide. I am inclined to think that the snout plays some part in helping the limpet to get home, as this organ is extremely sensitive, and certainly plays an important part in discovering suitable food. I intend carrying on more extended observations with a view to the more complete elucidation of this puzzling question in regard to the limpet's locality-sense, but this preliminary notice may possibly be of some interest. J. R. DAVIS

University College of Wales, Aberystwith

THE MEDITERRANEAN FAUNA[1]

VERY welcome to all zoologists, especially to those living in Europe, will be the first part of what promises to be a most useful work on the animals known to inhabit the Mediterranean Sea For more than twenty-five years Prof. J. Victor Carus tells us he has been collecting the materials for such a volume, and now that he has to be congratulated on the appearance of so much of it, we trust it may not be long ere we shall be enabled to announce that it is complete. The first part gives a list of the Cœlenterates, Echinoderms, and Worms. The next will treat of the Arthropods, Mollusks, and Vertebrates. The author on mature deliberation resolved to omit from the enumeration the Protozoa and Sponges, not seeing his way to give of these satisfactory detailed diagnoses, and also because, while Haeckel and others have done a good deal towards increasing our knowledge of the Mediterranean Protozoa, and Oscar Schmidt and others have done the same with the Sponges, yet the groups have not been rigidly systematised in the same way, for example, as the Cœlenterates.

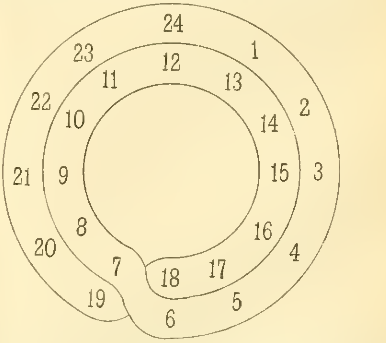
In the Prodomus, a diagnosis of each sub-order, family, genus, and species is given, with the synonymy of each species, its general distribution, and then its known habitats in the Mediterranean. When the species has been found only in the Mediterranean it is specially marked, the only exceptions we notice to this rule being in the case of the parasitic worms, and from the nature of their hosts they are just as likely as not to be found out of bounds. We have examined the list of the species with a good deal of attention, and have been greatly struck with the immense care that has been evidently used in its compilation. Many of the records and descriptions of these species are not to be found in monographs or special treatises on the fauna of certain well-known bays, like those of Naples, Marseilles, &c., but lie scattered over the numerous pages of our periodical literature, often difficult to be got at; indeed, in some few cases, we notice the record of the habitat is based on the authenticated examples in museums. In admitting some doubtful species on the authority of authors of good repute, Prof. Carus has acted wisely, for, should it be necessary, a stroke of a pen would suffice to reduce these to synonymic rank, while, should they be ultimately approved of, they are already in their places.

This Prodomus is dedicated to Sir Henry Wentworth Acland, K.C.B., who for these long years past has taken so much interest in zoology in connection with Christ Church, Oxford, and who well merits this tribute of respect and confidence from Prof. Carus. Those whose knowledge of zoology in Oxford only dates from the period of the New Museum, and who have no leisure for mastering the details of the past, may not be aware how much the collection of zoology and comparative anatomy owes to the labours of Victor Carus, who collected, we believe, for Sir Henry Acland during a great part of 1850, at the Scilly Islands, the series of British Invertebrates then placed in Christ Church Museum, and now Prof. Carus, having taken a larger area within his grasp, associates this Prodomus of its Fauna with our Oxford Professor, as a sign and token that he has not forgotten those earlier days.

[1] "Prodomus Faunæ Mediterraneæ, sive Descriptio Animalium maris Mediterranei incolarum quam comparata silva rerum quatenus innotuit adjectis locis et nominibus vulgaribus eorumque auctoribus in commodum Zoologorum congessit Julius Victor Carus." Pars 1. Cœlenterata, Echinodermata, et Vermes. (Stuttgart, 1884.)

OUR FUTURE CLOCKS AND WATCHES

IN connection with what we have said before on this subject we give a drawing of the new dial in use on some of the American railways where the new system is already



at work, the clocks indicating a certain number of hours plus Greenwich, according to the longitude of the section.

The intersection of the two circles of figures serves the purpose of giving day hours inside and night hours outside.

NOTES

THE Congress of the United States some time ago appointed a joint committee of senators and representatives to consider the organisation of the different bureaux of the Government. This special commission is now hearing the depositions of witnesses. The evidence of Major Powell, Director of the Geological Survey, has just been published. The principal feature of this document is the proposal to give the administration of the different bureaux to the Smithsonian Institution. It should be noted that the National Academy of Sciences passed some time back a resolution asking that a special administration should be created for the purpose. The Committee of the Academy recommended the establishment of a physical observatory to investigate the laws of solar and terrestrial radiation, and their application to meteorology, with such other investigations in exact science as the Government might assign to it; and they also recommended that the functions of the Bureau of Weights and Measures, now performed by the Coast Survey, be extended so as to include electrical measures.

THE Bureau of Navigation of the U.S. Navy Department announces that the computations and discussions of the observations and experiments for determining the velocity of light have been completed, and are being prepared for publication.

THE Fourth Circular of Information of the United States Bureau of Education reports the meeting of the Superintendents of National Education at Washington in February last, one of the largest of such meetings ever held. The principal papers read were on the subjects of Indian and Negro education. One speaker, who reported the former of these races to trust too much to memory and direct observation and too little to reasoning, nevertheless considered them worthy to be absorbed into the white population, though as an inferior element. This may be the best for the Indians, for the most hopeful view of another speaker who upheld the return of their educated youth to their old homes as a civilising power to the whole body, was that "not more than five out of thirty were given up as hopeless"! But as eminently qualified and well-paid men are required for even this result, and nature will probably protest strongly against the deterioration of a higher race by a lower one, the most satisfactory consideration seems that the Indian population is decreasing. But not so the Negro; and the inability of the Southern States to overcome the rapidly increasing mass of ignorance now cast upon them has led to the drawing up of a very cautious Act for the supply of national assistance to this necessary work during the next five years only. It is interesting to note that the Peabody Trustees are becoming quite an authority in educational matters. Another subject fully discussed, but, like the above, requiring little discussion in our country, was the advantage or disadvantage of a ten minutes recess during a three hours' school sitting; the objections to it, some of them social, would not be felt here. Out of our reach also, we fear, is the pleasanter matter of the plantation of trees as memorials of each great man or event at an annual school holiday. An interesting account given of the composition of those touching lines, "Woodman, spare that tree," concluded an eloquent paper on behalf of the practice. In an account of European technical education a very high place is awarded to the Swedes, who want nothing but qualified teachers. While one speaker urged that technical training should be the groundwork of education, and not a branch of fact-knowledge, another thought, that looking on at various manufactories and writing an account of what had been shown and explained to them, was of more general value. The immense increase of crime in the United States among educated young men was cited by one who expressed an enthusiastic belief that the greatest check to it would be the organisation among children of societies for the prevention of cruelty to animals. Dr. B. Joy Jeffries read a paper on colour-blindness, urging that the three primaries are red, green, and violet; that blindness to the latter is so rare that practically colour-blindness means blindness to red or green; urging also the danger of persons with such deficiency being employed in many occupations, and the necessity of an experimental method of finding it out. The Fifth Circular of Information consists of information and suggestions with regard to the great educational department of the New Orleans Exposition now opening, at which gathering the Superintendents of Education are to meet in the ensuing year.

HERR JADRINTSOW of St. Petersburg is about to publish, in Russian and German, a work on the Uralo-Altai, and Ugro-Turanian tribes of Siberia.

ACCORDING to the *Colonial Mail* a statement comes from the Cape Colony which is deserving the attention of botanists. It is alleged that insects shun the land on which tomatoes are grown; and the cultivation of the *Lycopersicon esculentum* is accordingly recommended in all cases where it is possible to grow it—under fruit-trees, for instance, since the tomato will thrive in the shade of other trees, which few other plants will do—for the sake of the virtues attributed to it as a prophylactic against the inroads of insect pests. It would be interesting to know whether the tomato has been observed to exercise any such effect on insects elsewhere—in Canada, for instance, where the fruit is so popular—or whether it is only in warmer climates, like that of the Cape, that its peculiar powers are brought into play.

M. MARCEL DEPREZ, the well-known electrician, is not confining his labours exclusively to the transmission of electrical force to distant places. In conjunction with others he has patented a new telephone based on a new principle of vibration, and dispensing with the use of voltaic elements. The lease of the Compagnie générale des Téléphones being about to expire, the Municipal Council of Paris have held a protracted sitting on the question whether the lease should be renewed or not. In the course of the discussion it was proposed to grant the renewal of the lease provisionally for a month, in order to give the new apparatus a fair trial. The further discussion of the question has been postponed to the next meeting.

THE last number of the *Mittheilungen der deutschen Gesellschaft für Natur und Völkerkunde Ostasiens*, Heft 31, contains a paper by Mr. Knipping, on weather telegraphy in Japan, which has already been referred to in NATURE. Besides describing the agencies at present at work in connection with the Central Meteorological Observatory, Mr. Knipping suggests a reorganisation of service, especially as regards the lighthouses; the number of stations would then be eighty in place of twenty-four, and the increased value of the service for practical as well as for scientific climatological purposes would be proportionate. Herr Mayet gives the first part of a full and interesting description of his visit to Corea with the German mission which went there last year for the purpose of making a treaty. If continued on the same scale, it will be the most comprehensive and accurate account of Corea, its Government, people, laws, &c., yet published. When at the capital, Seoul, the members of the mission noticed, from a hill in the grounds of their residence, the extraordinary sunsets of October in that year; but no special observations were made, because they believed that the beautiful phenomenon was the usual accompaniment of fine weather sunsets in Corea. It is described as sometimes resembling the aurora borealis. Frequently it was

only a uniform brilliant brightness, the centre of which was the spot at which the sun had gone down; other evenings the sun shot rays like long fingers, of a darker colour, athwart the glow, and in one evening the change of the light and darker colours of the evening red were like the incessant wavings of the folds of a perpendicular curtain. The effect of the phenomenon on the ignorant and superstitious inhabitants of Seoul, was of more immediate importance to the writer and his companions than its scientific aspects. They regarded it as a sign of trouble, war, and misfortune. Heavy rain which fell soon after averted any disaster from this cause.

A COMMISSION has been nominated by the President of the French Republic to investigate the archæology of Tunis, and report on the best method of preserving the ancient monuments of that country. A considerable number of specially-qualified French scholars have been appointed, and M. Ernest Renan has been named President of the Commission.

A SARCOPHAGUS with four face-urns has been recently found at Garzigar, near Köslin (Pomerania), and has been sent to the Antiquarian Provincial Museum of the Pomeranian Antiquarian Society at Stettin. A similar discovery was made last year at Klein Barkow (another Pomeranian village). Round one of the urns there was placed a bronze necklace, consisting of a stout bronze wire supporting eight so-called spectacle-spirals as ornaments. Prof. Berndt has proved in his work on Pomeranian face-urns, that they are really of Greek origin, dating from about the years 100 or 200 B.C., when Greek agents or factors went to live on the shores of the Baltic in order to trade with their home country in amber, furs, &c. Prof. Lindenschmidt (Mayence) and Dr. Schliemann indorse this opinion.

THE Imperial Japanese Meteorological Observatory has (according to the *Japan Mail*) issued a volume containing a series of monthly weather summaries for the months March to December 1883, each summary being accompanied by a map. The first weather map in Japan was issued on March 1, 1883, and the compilation therefore begins with that month. The greater part of the issue is occupied by twenty maps, indicating the tracks of centres of areas respectively of high and low barometers for the ten months dealt with, copious notes prepared from the daily telegrams being also furnished. For each month there is given the number of areas of high and of low barometer, with a short synopsis of the course of each, the place and date of highest and lowest temperature and barometric pressure, the number of gales, heavy gales, and hurricanes reported, with their localities, the occasions on which rain or snow fell, and the number of warnings issued. Lists are also given of the lighthouses from which gales were reported. These summaries are followed by monthly meteorological tables and illustrative maps, commencing two months earlier, and extending therefore over the whole of the year 1883. In these we find the mean temperature, mean pressure, altitude and rainfall for each month at twenty-two stations, and at the end there is a similarly prepared table for the whole year. The series closes with maps indicating by different degrees of shading the rainfall over the various parts of the empire during the twelve months, the aggregate rainfall for the year being shown by similar means in a final map.

AT the meeting of the Royal Physical Society of Edinburgh, held on December 17, the following office-bearers were elected:—Presidents: Benjamin N. Peach, F.R.S.E., John A. Harvie-Brown, F.R.S.E., Rev. Prof. John Duns, F.R.S.E.; Secretary: Robert Gray, V.P.R.S.E.; Assistant Secretary: John Gibson; Treasurer: Charles Prentice, F.R.S.E.; Hon. Librarian: R. Sydney Marsden, F.R.S.E.; Council: Patrick Geddes, F.R.S.E., Frank E. Beddard, F.R.S.E., Johnson Symington, F.R.C.S.E., Andrew Moffat, John Hunter, F.C.S., Robert Kidston, F.G.S., A. B. Herbert, William Evans Hoyle, M.R.C.S., F.R.S.E., Prof. James Geikie, F.R.S., Prof. J. Cossar Ewart, F.R.S.E., G. Sims Woodhead, F.R.C.P.E., Hugh Miller, F.G.S.

WE have received the October number of the *Proceedings* of the Boston Society of Natural History. It contains a continuation of Mr. Crosby's paper, meeting the objections advanced by Dr. Wadsworth against the author's views of the stratigraphy of the Boston Basin. It also contains a description, by Q. E. Dickerman and Dr. M. E. Wadsworth, of an olivine-bearing diabase, from St. George, Maine; as also the beginning of a paper by Thos. T. Bouvé, on the genesis of the Boston Basin and its rock-formation.

MESSRS. MACMILLAN AND CO. will very shortly publish a translation of the work of Dr. Hertel of Copenhagen on Over-Pressure in Middle-Class Schools in Denmark, with an introduction by Dr. Crichton Browne.

THE additions to the Zoological Society's Gardens during the past week include an Indian Civet (*Viverricula malaccensis*) from India, presented by Mr. W. Getty; a Bengalese Cat (*Felis bengalensis*) from India, presented by Mr. G. T. Egan; a Grey Parrot (*Psittacus erithacus*) from West Africa, presented by Mrs. Whitelow; a Kestrel (*Tinnunculus alaudarius*), a Sparrow Hawk (*Accipiter nisus*), British, presented by Mr. T. E. Gunn; a Broad-fronted Crocodile (*Crocodilus frontatus*), a Nilotic Crocodile (*Crocodilus vulgaris*) from West Africa, presented by Mr. J. M. Harris; an Undulated Grass Parrakeet (*Melopsittacus undulatus*) from Australia, deposited; two Golden-winged Woodpeckers (*Colaptes auratus*), a Blue Jay (*Cyanocitta cristata*) from North America, a Black-tailed Hawfinch (*Coccothraustes melanurus*) from Japan, two Red-headed Finches (*Amadina erythrocephala*) from South Africa, two Banded Parrakeets (*Palæornis fasciatus*), from India, received in exchange.

PHYSICAL NOTES

SEVERAL new primary batteries are in the field, and there are more to come. An iron cell invented by Dr. Pabst of Stettin is finding great favour in Germany. Its electrodes are carbon and wrought iron dipping into a solution of ferric chloride. It is practically unpolarisable and self-regenerating. It works at the expense of iron and of the oxygen of the air, which is absorbed into the liquid, whilst ferric oxide is deposited at the bottom of the cell. Its electromotive force is about ·78 of a volt. The Pabst cell ought to prove of value for domestic electric lighting, as its internal resistance is low and its constancy remarkable.

ANOTHER primary cell has the peculiarity that the element consumed in the liquid is carbon. In this cell—the invention of Profs. Bartoli and Papasogli—the electrodes are platinum, and a compacted mixture of retort coke and Ceylonese graphite. The exciting liquid is hypochlorite of soda. The electromotive force is, however, only ·2 of a volt at the most.

M. JABLOCHKOFF announces another battery of great scientific interest. A small rod of sodium weighing about 8 grammes is squeezed into contact with an amalgamated copper wire and flattened. It is wrapped in tissue paper and then damped with three wooden pegs against a plate of very porous carbon. This completes the element. The moisture of the air settles on the oxidised surface of the sodium. It works without any other liquid. The E.M.F. is 2·5 volts, but the resistance is as great as 25 ohms.

M. LAZARE WEILLER has shown that the phosphide of tin, drawn into wires, possesses a higher electric conductivity than platinum or iron.

M. EMILE REYNIER has made some very interesting experiments on the maxima and minima electromotive forces obtained from cells of one electrolyte. For this purpose he constructed two cells, one for determining the maxima and one for determining the minima electromotive forces. His maximum cell consists in giving the positive electrode as large a surface as possible—about 30 square decimetres—while the negative electrode consisted of a wire of 3 mm. diameter. The positive electrode was bent round

in the form of a sharply corrugated circle, and the negative electrode was placed in the centre, so that the resistance should be low, it varied from ·2 to 4 ohms according to the liquid used. The E.M.F. was practically constant during its determination, as the current drawn from the cell was only about ·001 ampere. The minimum cell was of similar form to the maximum, only the positive electrode was in the centre and was a wire of about 0·5 mm. diameter, and the negative electrode was in the form of a cylinder. By using cells of these forms he was able easily to change either of the electrodes or the electrolyte. The method of determining the minima electromotive forces was to short-circuit the cell for several hours, and immediately on opening the circuit to determine the E.M.F. The following are some of the results that he obtained with an electrolyte of acidulated water, 2 parts in 1000 being sulphuric acid :—

Electrodes			E.M.F. in volts	
Negative		Positive	Maxima	Minima
Zinc,	ordinary	Carbon	1·22	0·04
,,	amalgamated	Carbon	1·26	0·226
,,	ordinary	Lead	0·55	0·144
,,	amalgamated	Lead	0·684	0·152
,,	ordinary	Copper	0·94	0·194
,,	amalgamated	Copper	1·072	0·272
,,	ordinary	Iron	0·429	0·309
,,	amalgamated	Iron	0·476	0·323
,,	,,	Zinc, ordinary	—	< 0·09
Iron		Copper	0·49 to 0·51	—

AN experimental reproduction on the screen of the phenomenon of the solar halo has been recently brought before the Physical Society of Paris by M. Cornu. M. Cornu also discussed the phenomenon of the pink corona which has been visible around the sun during the past few months. He thinks it has its seat in the atmosphere at an elevation considerably higher than the level of the cirrus clouds which give the common ring-halo of 22°. According to M. Cornu the polarisation of the sky has been "profoundly modified" by the present phenomenon, especially when viewed through red glass.

SIGNOR A. RICCO sends us a lengthy memoir on a new form of electro-magnet invented by him. It consists of a sheet of iron rolled into a spiral round an iron core, the convolutions being separated by oiled paper. The current traverses the coiled sheet, which thereby becomes powerfully magnetised. A spiral of forty turns of insulated copper wire is added outside. The lifting power of this magnet appears to be very great in proportion to its weight.

A PAMPHLET on the system of simultaneous telephony and telegraphy invented by F. van Rysselberghe has lately appeared from the pen of M. Ch. Mourlon, secretary of the Société belge d'Electriciens.

DR. E. VON FLEISCHL recently communicated to the Viennese Academy a paper on the double-refraction of light in liquids. Concentrated solutions of tartaric acid and of various sugars were employed, also certain active oils, in a compound hollow prism resembling a Fresnel's quartz combination in its general disposition. The research proves the existence of doubly-refracting liquids ; but they possess no optic axis. The wave-surfaces are in every case two concentric spheres.

CHEMICAL NOTES

ATTENTION was lately drawn in these Notes to Schiff's recent researches on the connections between the capillary coefficients of various liquid carbon compounds and the structure of the molecules of these compounds (see also NATURE, vol. xxx. p. 618). The same subject has very recently been examined by J. Traube (*Ber.* xvii. 2294). Traube thinks that the differences between the various capillary elevations observed by Schiff are too small to allow of trustworthy conclusions being drawn : he has therefore undertaken a series of observations with aqueous solutions of various classes of carbon compounds. Inasmuch as the capillary elevation of water in a tube of ·34 mm. radius is about 41·5 mm., while that of most liquid carbon compounds does not exceed 25 mm., Traube concluded that there will probably be well-marked differences between the capillary elevations of aqueous solutions, and mixtures of aqueous solutions, of definite concentration, of various compounds of carbon. The height in capillary tubes was determined for each solution for varying degrees of concentration, and the results are stated for equal weights of compounds in equal volumes of solution. From these results Traube draws the conclusions :—(1) The capillary elevation of the solution of a compound decreases as concentration increases ; the differences of elevation are not equal for equal increases in concentration. (2) The capillary elevations decrease in a homologous series of carbon compounds as molecular weight increases. (3) Isomeric compounds in solutions of equal concentration do not always exhibit equal capillary elevations. Schiff's generalisation, that the number of molecules of isomerides raised by capillary action is equal, does not hold good for aqueous solutions of isomerides. As in Traube's experiments the liquids examined were of equal concentration, it follows that the ratios of the capillary elevations are equal to the ratios of the masses of the dissolved compounds raised in the capillary tubes. Calling the capillary elevation h, and the specific gravity of the solution s, Traube considers the product hs, which he calls the capillary coefficient of the solution. The value of h is conditioned by the chemical constitution of the compounds examined. If m = molecular weight of compound in solution, then the difference between $\frac{h}{m}$ for solutions of two compounds, within certain limits of concentration, is a constant which depends only on the relative concentrations of the two solutions. The values of $\frac{h}{m}$ for an homologous series, dealing with solutions containing equal masses of the compounds in equal volumes, are referred to the value of $\frac{h}{m}$ for the first member of the series, and the differences thus obtained, when calculated for a tube 1 mm. radius, are called the *specific capillary constants* of the compounds in the series. The values of this quantity are almost wholly dependent on the nature of the solution, perhaps only on the nature of the dissolved substance, and are independent, within certain limits, for each homologous series, of the absolute concentration of the solutions, and are scarcely, if at all, dependent on temperature. Traube thinks he is justified from his experimental results in concluding that the differences between the capillary elevations of the solutions of two analogous compounds are in the same ratio as the molecular weights of the compounds. Thus, let h_α and h_{α_1} represent the capillary elevations of two solutions, of different concentrations, of the compound with molecular weight m ; and let h_β and h_{β_1} represent the capillary elevations of two solutions, of the same concentration as those of the former compound, of an analogous compound with molecular weight m_1. Then, according to Traube,

$$\frac{h_\alpha}{m} - \frac{h_{\alpha_1}}{m_1} = \frac{h_\beta}{m} - \frac{h_{\beta_1}}{m_1};$$

therefore

$$\frac{h_\alpha - h_{\alpha_1}}{h_\beta - h_{\beta_1}} = \frac{m}{m_1}.$$

If, therefore, h_α, h_{α_1}, &c., are determined, the ratio $\frac{m}{m_1}$ can be found ; and if m is known, the value of the molecular weight of the second compound (m_1) can be calculated.

GEOGRAPHICAL NOTES

WE are glad to see that at last there is some probability of the almost unknown but certainly interesting country of Tibet being opened up to outsiders. We know the frequent but unsuccessful efforts which Prjevalsky and others have been recently making to penetrate to Lassa. But now the *Times* Calcutta correspondent informs us that the Regent of the Tashu Lama at Shigatze has sent a most cordial reply to the letter which Mr. Macaulay despatched to him from the frontier through the agency of the Governor of Kambajong, and has also addressed a letter to the Viceroy. With these letters, besides the silk scarves which ordinarily accompany Tibetan correspondence, the correspondent understands he has sent some relics of the late Tashu Lama himself, and has asked Mr. Macaulay to send him a Tibetan-English dictionary and phrase-book and some scientific instruments. This is the first official communication received from Tibet for about a hundred years. The correspondent suggests that the Government should put our relations on a firm footing by sending at once a friendly mission in connection with the identification which takes place this year of the infant in whom Tashu Lama is supposed to have been born again.

THE town of Bhamo, in Upper Burma, the destruction of which by the Kakhyen tribes is reported from Rangoon, is one well known in the exploration of South-Western China in recent years. The route so often traversed from Shanghai to Rangoon by the Yangtsze, Talifu, and the Irrawaddy passes through Bhamo. It is mainly a trading town, from which the caravans start into Yunnan, as here the navigation of the Irrawaddy ceases. The first modern explorer to visit it was Mr. Cooper, the traveller "in pigtail and petticoats," who journeyed so courageously throughout South-West China during the Mohammedan rebellion. The Indian Government was disposed at that time to pay more attention to a trade route into Yunnan than they appear to have been recently, and the importance of Bhamo on the route from British Burmah was recognised by the appointment of an agent to reside there, and gather information useful for commerce in these regions. Mr. Cooper, the most competent man for the post, was selected, but the good work which he was doing was cut short by his death one night in his tent near Bhamo, at the hands of one of his Burmese guards. At Manwyne, not far on the Chinese side of Bhamo, Mr. Margary was murdered in 1876, when on his way from the Yangtsze and Talifu, to meet Col. Browne's expedition, which advanced from Rangoon along the Irrawaddy, through Bhamo. A year later it was visited by the Commission of English officials under Mr. Grosvenor, which went to inquire into Margary's death; and, on account of the place being within easy reach of Rangoon and Mandalay by the river, it has been frequently visited by officials of the Indian Government, such as Cols. Browne and Fytche and Major Sladen. The latter's journey had for its object the removal of dangers to traders on the route from the Kakhyens, and he succeeded in coming to an understanding with the chiefs to keep the route open. Within the last few years McCarthy, on his way from Shanghai by the Japanese route, and Colquhoun from the capital of Yunnan, passed through the town. It was a small stockaded settlement of Chinese and Shan traders, with a lower order of Burmese, and there is a French missionary station at the place, while some Americans are also engaged in missionary work there and at Mauwyne. The Kakhyens inhabit the greater part of North-Eastern Burmah, between the Irrawaddy and Salween, and live mainly on the trade between China and Burmah, either as brigands and robbers or as carriers on the river and roads. In addition, they appear to trade a little on their own account. The grounds of their destruction of the town are unknown, but it is probably due to their predatory habits, the comparative wealth of the town as a central trading station in the region, and the weakness and incompetence of the native government of Upper Burmah, especially in a wild and remote border-land, such as that in which Bhamo is situated, and of which it is the capital.

AN interesting expedition has been undertaken by Mr. Shaw, a naturalist and artist of Sydney, New South Wales. He proposes to make a canoe voyage down the Lachlan, Murrumbidgee, and Murray rivers, his object being to enlarge our knowledge of the interior river-systems of Australia, and of natural history. The cost of the expedition is borne by the *Town and Country Journal* of Sydney, in which the artist's sketches will no doubt appear.

WE learn from the Australian papers that Mr. E. M. Curr of Victoria has been engaged on a work on the customs, language, and origin of the aborigines of Australia. Portions of the manuscripts were, early last year, sent to England to be submitted to the Council of the Anthropological Society. The Society has expressed the opinion that the Government of Victoria should publish the vocabularies and a record of the customs of the aborigines, as, otherwise, valuable information might be lost for ever. It is expected that arrangements will be made for the publication of the work at the public expense.

REPORT OF THE LONDON SCHOOL BOARD COMMITTEE ON TECHNICAL EDUCATION

WE are glad to publish the following Report on Technical Education which has been presented to the London School Board. The recommendations contained in it were passed on December 18, 1884, with a small modification in No. 5. The only one which received any serious opposition was No. 6, which relates to the Swedish Slöjd system, but this ultimately passed by a majority of two to one.

(1) *Constitution of Committee*

On February 1, 1883, the Board passed the following resolution:—"That a Special Committee be formed to consider and advise how far the Board may facilitate Technical Education, or co-operate with those bodies that are carrying it on."

On February 8, 1883, the Board resolved:—"That the Special Committee on Technical Education agreed to by the Board on February 1, 1883, consist of the following Members:—Mr. Roston Bourke, Mr. Bousfield, Mr. Bruce, Sir Edmund Currie, Miss Davenport Hill, Prof. Gladstone, Mr. Heller, Sir Arthur Hobhouse, Mr. Lucraft, Miss Muller, Rev. Henry Pearson, Mr. Lee Roberts, Mr. Whiteley, Mr. Mark Wilks, and *ex officio* the Chairman and the Vice-Chairman of the Board."

At the first meeting Prof. Gladstone was appointed Chairman of the Special Committee. Nine meetings of the Committee have been held.

(2) *Information from Gentlemen*

The Committee commenced their deliberations by endeavouring to obtain information from gentlemen who were interested in, and had studied, the subject.

The following gentlemen accordingly attended the Committee by invitation, and gave their views on the subject:—Dr. Silvanus P. Thompson, Professor of Natural Philosophy at University College, Bristol; Mr. H. Trueman Wood, Secretary of the Society of Arts; Mr. Philip Magnus, B.Sc., B.A., Director and Secretary of the City and Guilds of London Institute for the Advancement of Technical Education, and one of the members of the Royal Commission on Technical Instruction. The statements of these gentlemen are set out in detail in the Appendix to this Report.

(3) *Information from School Boards*

The Committee also obtained information from the clerks of the Glasgow, Manchester, and Sheffield School Boards respecting the steps taken by these Boards respectively for the instruction of children in technical education.

Glasgow, Allan Glen's Institution.—At the request of the clerk of the Glasgow School Board, Mr. A. Crum Maclae, Secretary of Allan Glen's Institution, Glasgow, replied, furnishing information respecting the technical instruction in that institution, and inclosing—(1) a prospectus of the school for 1883-84; (2) a report of the proceedings at the distribution of prizes and certificates in December, 1882; (3) a copy of a paper on the "Relation of the School to the Workshop," read before the Philosophical Society of Glasgow in December, 1882, by David Sandeman, Chairman of the Weaving Branch of the Technical College, and E. M. Dixon, B.Sc., Head Master of the Institution.

Manchester School Board.—The Clerk of the Board, in reply to the inquiry of the Committee, furnished information to the effect that the Board have no present intention of starting a technical school; that this work had been taken up by the trustees of the Manchester Mechanics' Institute, who have converted that institution into a technical school; that the Board have introduced a lathe and a group of joiners' benches into class-rooms of two of their schools, and each scholar in the higher standards of the school takes his turn at the manual exercises, receiving one or two lessons a-week, a joiner being present to give the instruction. No extra charge is made for the instruction. One of the schools is the lowest under the Board, where two-thirds of the children are admitted free, the other being attended by children of artisans and small shopkeepers.

Sheffield School Board.—The Clerk of the Board gave particulars respecting the admission, the examination, the fees, the subjects of instruction, and the results of the Central Higher School established in that town. In the workshop attached to the school the practical work contemplated will include—(1) the production of simple but perfect geometrical forms to teach accuracy and skill in the use of tools; (2) the construction of models in wood for use as examples in model drawing; (3) the construction of simple apparatus to illustrate, by actual experiment, the principles of levers, pulleys, wheel and axle, the crane and strain on beams with different positions of load; (4) the mechanics of the roof, arch, and bridge; (5) for more advanced pupils the construction of apparatus illustrating lessons in machine construction, applied mechanics, building construction, and mechanical engineering. It is added that there is a system of scholarships by means of which from fifteen to twenty specially clever boys and girls will be enabled to pass from the

ordinary schools to the technical instruction at the Central Higher School.

(4) *Action of British Association and Social Science Congress*

The Committee were officially informed by the chairman that a resolution had been passed in 1883 by the British Association for the Advancement of Science requesting a Special Committee "to consider the desirableness of making representations to the Lords of the Committee of Her Majesty's Privy Council on Education in favour of aid being extended toward the fitting-up of workshops in connection with elementary day schools or evening classes, and of making grants on the results of practical instruction in such workshops under suitable direction." The said Committee waited to see the Report of the Royal Commissioners, and expressed their approval of recommendation (*d*), which practically covers the same ground. The Social Science Congress has made a presentation to the Education Department to a similar effect.

(5) *Recommendations of the Royal Commissioners on Technical Education*

During the deliberations of the Committee the second Report of the Royal Commissioners on Technical Education, containing their recommendations, was published, and the Committee submit, for the information of the Board, the recommendations as to public elementary schools, as follow :—

(*a*) That rudimentary drawing be incorporated with writing as a single elementary subject, and that instruction in elementary drawing be continued throughout the standards. That the Inspectors of the Education Department, Whitehall, be responsible for the instruction in drawing. That drawing from casts and models be required as part of the work, and that modelling be encouraged by grant.

(*b*) that there be only two class subjects, instead of three, in the lower division of elementary schools, and that the object lessons for teaching elementary science shall include the subject of geography.

(*c*) That, after reasonable notice, a school shall not be deemed to be provided with proper "apparatus of elementary instruction" under Article 115 of the Code, unless it have a proper supply of casts and models for drawing.

(*d*) That proficiency in the use of tools for working in wood and iron be paid for as a "specific subject," arrangements being made for the work being done, so far as practicable, out of school hours. That special grants be made to schools in aid of collections of natural objects, casts, drawings, &c., suitable for school museums.

(*e*) That in rural schools instruction in the principles and facts of agriculture, after suitable introductory object lessons, shall be made obligatory in the upper standards.[1]

(*f*) That the provision at present confined to Scotland, which prescribes that children under the age of fourteen shall not be allowed to work as full-timers in factories and workshops, unless they have passed in the Fifth Standard, be extended to England and Wales.

(6) *The Slöjd System of Handicraft in Sweden*

The Committee have received valuable information respecting a system of instruction in handicraft, which is largely adopted in the elementary schools of Sweden. Two mistresses under this Board, Miss Warren, head mistress of the infants' department of the Carlton Road, Kentish Town, School, and Miss Clarke, head mistress of the infants' department of the Campbell Street, Maida Vale, School, were allowed an extended summer vacation, in order that they might visit Herr Abrahamson's Institution at Nääs, near Gothenburg, in Sweden, where instruction is given in handicraft. This institution is established and maintained by Herr Abrahamson on his own estate, for the purpose of training teachers in the system, in order that the teachers may be able to carry it out in their schools.

The Governments of some other countries were invited to send teachers to Nääs to learn the system, and through Miss Löfving, formerly Superintendent of Physical Education under the Board, the invitation was extended to two mistresses of the schools of the Board. Hence the visit of Miss Warren and Miss Clarke during last summer. These mistresses have returned with diplomas received from Herr Salomon, the Director of the "Slöjd" Seminarium at Nääs, for having successfully completed the set of articles required for the first course of the system.

Miss Warren stated that during the two months leave of absence which had been granted to her and Miss Clarke, they had, at the invitation of Herr Abrahamson, visited his institution, with the object of becoming acquainted with his system of instruction in handicraft. The work done is carried out in wood, and the general term of "Slöjd" is applied to it. Working in wood is considered the most useful, as by working in this material the advantages claimed for the system are obtained more easily and completely than by the adoption of any other material. Miss Warren exhibited to the Committee forty articles in wood, selected from the 100 articles, forming the course of instruction, which she had made during her visit. The system of instruction is divided into what is called the "Nääs" system, from the estate on which it is carried out, and the "Artisan" system. The "Nääs" system differs from the "Artisan" in that it is not called a trade, the work, mainly in wood, being carried out under the superintendence of a *teacher*, and not being sold.

The work is done in a room fitted with benches, the room being about the size of one of our smaller halls. Only one teacher is in this room. The tools used all come from England and America. The cost of the tools per child is about 30 kronor, or 32*s.* 6*d.* The cost of the wood for 100 models is, *in Sweden*, about 15 kronor, or 16*s.* A complete set of the tools required could be obtained for about 4*l.* 10*s.*

The object of the system is not so much to produce the articles as to educate and train the child itself. The promoters of the system claim for it five distinct advantages :—

(1) It produces in a child a love of manual labour.

(2) It promotes the development and training of a child's hands and fingers.

(3) The child learns order and exactness.

(4) It educates a child's observation and perceptive faculties.

(5) It teaches self-reliance.

The school hours in Sweden are from 8 a.m. to 1 p.m., with an interval of a quarter of an hour about eleven o'clock. The instruction in "Slöjd" is usually taken in the afternoon. About two and a half hours on three days a week are devoted to this work. "Slöjd" is encouraged and paid for by Government, but is not compulsory. Children begin the work at about ten years of age. It is a punishment for a child to be withheld from it. Everything made is a *useful* article, the making of toys being prohibited. The articles when finished are given to the children as an encouragement. The child who does not succeed in the ordinary subjects of study is frequently encouraged on being successful in "Slöjd."

(7) *The Peripatetic System of Science Teaching in Birmingham*

In the course of their deliberations the Committee have noted and carefully considered the system of science teaching adopted by the Birmingham School Board. This system is sometimes called the "peripatetic" system. "The elementary science "is taught in accordance with a syllabus, by a practical demonstrator and assistant (who visit each boys' and girls' department once every fortnight), and by the teacher of the school. The Science Demonstrator for the Board (or an Assistant Demonstrator) gives one lesson fortnightly of about forty minutes' duration to the boys in the Fifth and higher Standards in each school. The lessons are illustrated experimentally by specimens and apparatus carried from school to school in a hand-cart. Between the visits of the Science Demonstrator at least one lesson is given to the same class by the teachers of the respective schools (as a rule by a teacher who was present at the Demonstrator's lesson, and took full notes of it), and a written examination on the subject-matter of the lesson is also held. The answers are corrected by the class teacher and submitted to the Demonstrator at his next visit to the school. A general examination in elementary science is held yearly." The syllabus for boys comprises demonstrations on force, the mechanical powers, machines, parallelogram of forces, &c.; and that for girls demonstrations on the structure of the human body, circulation and respiration, the organs of digestion, the nervous system, the nature of food and its preparation, apparatus for cooking, how to maintain the body in health, the sick room, diseases of children, accidents, &c.

(8) *Conclusions*

After considering in all its bearings the whole question of the introduction of technical education and training into the schools of the Board, the Committee are of opinion that there is at present too little instruction for boys which is calculated to train and exercise the hand and fingers, so as to fit lads more efficiently

[1] This recommendation will not apply to London schools.

for situations where skilled manual labour is required. In this respect boys are worse off than girls. It is only in the drawing lesson that the boys receive any training of the hand, whilst girls obtain it in the needlework and cooking lessons as well. The Committee do not consider it desirable to attempt to teach any special trade or handicraft in the schools of the Board; but they are of opinion that in boys' departments greater attention should be paid to the teaching of "elementary science" and to freehand drawings from models; that mechanical drawing and modelling in clay should be introduced; that the peripatetic plan of teaching mechanics should be tried as an experiment in some district in London; and that, as an experiment, arrangements should be made for the establishment of a class for the elementary instruction of boys in the use of tools as applied to working in wood, the attendance being voluntary and out of school hours.

The Committee desire to express their high appreciation of the services rendered by Mr. Thomas Smith, and the zeal with which he has assisted them in their work.

(9) *Recommendations*

The Committee accordingly submit for adoption the following recommendations, which are intended to apply to boys' departments only:—

(1) That it is not desirable to attempt to teach any special trade or handicraft in the schools of the Board.

(2) That the instruction in drawing commence with Standard I. and be carried out according to a graduated scheme laid down for each standard.

(3) That increased attention be paid to freehand drawing from models in all schools, and that mechanical drawing and modelling in clay be introduced into certain schools.

(4) That greater attention be paid to the teaching of "elementary science" in the schools of the Board.

(5) That the peripatetic plan of teaching "mechanics" be tried in some district or districts of London.

(6) That, as an experiment, arrangements be made for the establishment of a class for the elementary instruction of boys in the use of tools as applied to working in wood, the attendance being voluntary and out of school hours.

(7) That the above resolutions be referred to the School Management Committee, with instructions to carry them into effect.

(8) That the sum of 10*l*. be paid to Mr. Thomas Smith, Principal Clerk of the School Management Department, as remuneration for his extra services in connection with this Committee.

(Signed) J. H. GLADSTONE, *Chairman*
B. LUCRAFT
H. D. PEARSON

APPENDIX

Statements of Dr. Silvanus P. Thompson, Mr. H. Trueman Wood, and Mr. Philip Magnus

I. Statement of Dr. Silvanus Thompson, Professor of Natural Philosophy at University College, Bristol, made before an informal meeting of the Committee on Technical Education, April 17, 1883.

Prof. Thompson stated with regard to drawing, that in his opinion the drawing taught and paid for by results by the Science and Art Department was not of the character which he considered should be taught. The subject he wished to see taught was what he liked to call industrial drawing, by which he meant that a block of wood or metal being placed before the children, they should execute from it drawings showing it in two or three different ways, exactly in the fashion in which workmen's drawings are made. Drawings made to scale represented in the workmen's fashion would be very much more valuable than the drawings executed under the regulations of the Science and Art Department. Industrial drawing such as this may be made applicable to all kinds of work, carpentry, masonry, &c.

He then described a lesson on drawing given in Paris on the general mechanism of tools. The lesson consisted in the master sketching roughly on the blackboard the outlines of certain pieces of machinery. He had neither compasses nor ruler. Every line had a distinct meaning, and every single detail was labelled. The boys were then told to make proper working drawings from this sketch. This kind of training seemed to him a very valuable thing. To know how to "read" a drawing is much more important than to turn out a highly-finished work of art. The main difficulty in introducing such a system would be that it would have to be created. No instructor in technical education had yet made it worth his while to evolve a system.

Prof. Thompson suggested that a section of certain schools might be devoted to the teaching of handicrafts. Some of the ordinary handicrafts in wood or metal would be good subjects to commence with. It would be better to try the experiment in one small school unless the Board are prepared to go to a very great expense.

He considered that a good deal might be done in training the hand and the eye by the introduction of clay modelling. As illustrating the value of modelling in clay, he stated that in Paris the masters' union for the manufacture of jewellery had established a little school for teaching the knowledge and practice of art required in making jewellery. In this school there is modelling in clay and wax, drawing from the cast and from the flat, and also a little actual model work. Various works of art are hung round the room, and from the cast the pupils model in clay. After that there is a course of modelling in wax. The children are about nine or ten years of age. Some begin their attendance here as early as eight.

Cutting stone and carving in wood are good subjects. Plastering is merely pouring plaster into a mould, and mechanics is not of a very technical order. He doubted whether glass-blowing would be useful. The opinion of the union was greatly against the increase in the number of apprentices. Glass-blowing was taught at a disadvantage in England, because the union would not sanction each master having more than one boy.

The subjects that might be taught to girls are wood carving, vellum painting, the making of artificial flowers, and dress-making. Engraving would be expensive. A great deal of chain-making is done by female labour, but there is not much to learn in it.

He knew of no place where these handicrafts were carried on, with the exception of a few orphanages.

II. Statement of Mr. H. Trueman Wood, Secretary of the Society of Arts, made before the Special Committee on Technical Education, June 13, 1883.

Mr. H. Trueman Wood gave the Committee some informatio about the origin of the City and Guilds Institute for the Advancement of Technical Education, with the foundation of which he had been associated. The work which that Institute was now engaged upon the Committee would have more fully set before them by Mr. Magnus. He gave a brief sketch of the movement which, originating in a proposal to establish a Technical University in London, had resulted in the formation of the City Institute, with its "Central Institution" now in course of erection at South Kensington, and its Technical Schools in Finsbury and Lambeth. He also described the system of Technological Examinations which, originated by the Society of Arts, had been taken over by the Institute, and developed to its present condition by the aid of a scheme of payment on results, similar to that of the Science and Art Department.

Mr. Wood, in reply to various questions put by Members of the Committee, gave the following additional information:—As regards those who attended the school in Finsbury, he could not speak with any knowledge, but he did not think that the larger proportion of them were artisans; he believed they were chiefly clerks and young people of the usual science student class. Some of them, he understood, were boys from the Middle-Class School in Cowper Street. He did not know of any school where boys of the artisan class of twelve or fourteen years of age could go and learn the use of tools, and he was not aware of the existence of any such school in England. He stated that he was strongly of opinion that mechanical drawing should be taught in all elementary schools. The industrial training given in industrial schools was, of course, one form of technical education, but he should scarcely include this in what should be taught in elementary schools. He was of opinion that it was not possible to give definite technical instruction in elementary schools; the children were too young, and, in many cases, it could not be said which trade they would follow in after-life. He did not himself see how more could be done than was being done in Birmingham, where, he understood, practical teaching in elementary science was given to the children. Such teaching as this he believed to be most valuable, and the best possible preparation for the specialised technical instruction which would come later on. Elementary mechanics should certainly be taught and should be illustrated by suitable apparatus. He quite

agreed that general instruction in handicraft would be useful, teaching children the use of tools without reference to special trades, and, he believed, the experiment of fitting up a workshop in one school was one that was worth trying, and would not be, in his opinion, very costly. He left, as an open question, whether such workshop should be used in playtime, or during the ordinary school hours.

III. Statement of Mr. Philip Magnus, B.Sc., B.A., Director and Secretary of the City and Guilds of London Institute for the Advancement of Technical Education, and one of the members of the Royal Commission on Technical Instruction, made before the Special Committee on Technical Education, July 4, 1883.

Mr. Philip Magnus gave the following evidence:—

He stated that there is a double object in the establishment of the Central Institution, now in course of erection at South Kensington. On the one hand, it is intended to give the highest technical education to persons preparing to become engineers, manufacturing chemists, and managers of industrial works, and other persons engaged in scientific research in its application to particular trades. On the other hand, it is especially intended as a training school for technical teachers. The latter function of the institution is considered the more important, because the experience of all persons connected with technical education has shown that there is a great need of duly qualified technical instructors in all parts of the kingdom. It is very likely that arrangements will be made by which teachers will be able to come up to London in the summer months and to obtain lessons in applied science and in the best methods of technical teaching.

As regards the students who attend the Technical College, Finsbury, he wished to say emphatically that a large portion of them are artisans. There are indeed two classes of students who attend the Finsbury Technical College: one class coming in the daytime and the other in the evening. The evening students are almost all engaged in industrial work, and very few of them are clerks. Of those who attend in the daytime, he might say, none are clerks. A few have already been engaged in industry, and, feeling the want of technical instruction, have given up their trade to devote a year or two to study; but the great majority are youths who intend to follow industrial pursuits, and are carrying on their studies with that object. The total number of students in attendance at the College in the evening classes is 621, of whom 132 are apprentices admitted at half the usual fee. Of the day students there are at present about 100 in attendance, the school being opened under its present organisation only in February last. These students come from various middle-class and higher grade schools. A fair proportion of boys are expected to come from the Cowper Street schools, immediately adjoining the college. At the same time it is hoped that pupils will come to the College from other schools of the same grade. It is indispensable that the boys to be admitted should have a good knowledge of arithmetic and of the rudiments of mathematics; *i.e.* they should be able to solve simple equations and understand thoroughly the first book of Euclid.

In answer to the question whether the Finsbury Technical College could be made available to boys from elementary schools, Mr. Magnus said he saw no reason why boys from the higher grade of elementary schools, possessing a knowledge of elementary mathematics, should not be admitted into the College.

In answer to the Chairman, he said it would be well for candidates for admission to have some knowledge of the principles of science, although such knowledge is not absolutely necessary, as some of the Professors of the College stated that they would almost as soon commence the teaching of science as continue the instruction of badly taught students.

The limit of age for the admission of students is fixed at fourteen. Students entering at fourteen, having a fair knowledge of the elements of algebra and geometry, and an acquaintance with some of the principal facts of physical science, would be well able to go through the prescribed courses of the Finsbury College; and such knowledge might be acquired by boys who had passed through the higher Standards, and had taken mathematics and mechanics as specific subjects.

Mr. Magnus thought it would be preferable that boys leaving the Board Schools should be selected about the age of twelve or thirteen, and drafted into higher elementary schools where they might receive the necessary instruction in mathematics and science, and that they should be drafted from these higher elementary schools to the Finsbury Technical College.

The subjects taught at the Finsbury College are practical science, including physics, mechanics, mathematics, and chemistry, mechanical and freehand drawing, handicraft work, French or German, or both. In the workshops the students are taught to work in wood and metal at the bench and at the lathe. They learn not only the use of tools, but to chip, file, turn, and to construct simple apparatus.

(Mr. Magnus here put in evidence his address at the opening of the Finsbury College, as well as the programme of instruction.)

Apprentices and workmen attend the evening classes to learn the more difficult operations of their trade, and to gain an insight into the processes of which they cannot always obtain satisfactory explanation in the shop. It is to correct the effects of extreme division of labour that evening technical classes are most needed.

As regards carpentry and joinery, the institute is now endeavouring to devise a scheme of evening instruction in connection with the technological examinations, which will probably lead to the establishment of evening classes in this subject in several provincial towns.

Having been asked how the School Board might aid in the development of technical education, Mr. Magnus said that the Board might aid in various ways.

Instruction could be given in the elementary schools in machine drawing. Better instruction might also be given in freehand drawing, of the defects of which the institute's examiners in technology generally complain. In a large number of schools workshops might with advantage be established, in which a certain number of the more advanced boys might have the opportunity of gaining instruction in the use of tools, in the same manner as is done in the primary schools in France under the new Act. It would be a great advantage to the boys on leaving elementary schools, be their occupation what it may, to have acquired the facility of using their hands, and to have gained a knowledge of the properties of different kinds of wood, as well as of iron and other metals, which could only be obtained by working these substances themselves. By the establishment of workshops in schools, the boys, when apprenticed, would advance more quickly in their career, and reality would be given to their scientific instruction as well as to their lessons in mechanical drawing. He considered the great want of this country to be higher elementary or intermediate schools of a technical character. As regards the scheme of education to be given in such schools, he referred to his address on "Technical Instruction in Elementary and Intermediate Schools," delivered before the Society of Arts. He thought that scholars who distinguished themselves at the ordinary elementary schools should be sent to technical schools of this description in preference to such schools as the City of London School or King's College School. Here, in England, education is too distinctly and exclusively literary. We want schools in which practical science, mathematics, and modern languages shall be the chief instruments of education. It has been the object of the City and Guilds of London Institute partly to supply the deficiency by supplementing the existing educational machinery. The Central Institution at South Kensington will, doubtless, exert considerable influence on all schools leading up to it. It will show that there is a school of the same grade as the ancient Universities, giving a practical scientific training instead of a literary or theoretical education. The selected boys from primary schools should be led up to the Technical University or Central Institution rather than to the existing Universities, where they are too often drafted into professional careers which are already overcrowded.

In answer to an inquiry as to the view Mr. Magnus held as regards the value of the study of English literature in schools, Mr. Magnus stated that he attached the highest importance to the study of English literature in higher elementary schools as developing the imagination and giving pupils a taste for reading.

Besides mechanical and freehand drawing, pupils having a taste for art should be taught modelling, the study of which is not sufficiently developed in this country.

He considered that geometry should be taught practically without Euclid; whilst Euclid is very valuable to those who wish to become thorough mathematicians, he thought that very few of those who learn the elements of Euclid derive any practical benefit from the study. Abroad, geometry is generally taught without Euclid.

As regards the technological examinations, Mr. Mangus said that four years ago the institute took over these examinations from the Society of Arts, which had previously conducted them under somewhat different conditions. The candidates have increased very much during these four years, especially those in mechanical trades. At the time of the transfer of the examinations, the number of candidates was 212, whereas this year, 1883, the number of candidates amounted to 2397.

The Council of the Institute are very desirous that scholarships should be established in connection with the Finsbury College and other similar technical Colleges throughout the kingdom, to enable promising pupils to carry on their education at the Central Institution. If children could be taught sufficient mathematics and elementary science to be transferred from the Board schools to the Finsbury College, or to some other technical school, and thence to the Central Institution, he considered the ladder of technical education would be complete.

He thought that the Board might further aid in assisting technical education by the loan of its rooms for the formation of evening classes, it being always understood that, in order that the instruction should be of any use, it must be of a practical character, and that the classes should be well furnished with all necessary models, apparatus, &c.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

MR. THOMAS PURDIE, Ph.D., B.Sc., Associate of the Royal School of Mines, has been appointed Professor of Chemistry in the University of St. Andrews, vacant by the retirement of Dr. Heddle.

SOCIETIES AND ACADEMIES

LONDON

Linnean Society, December 4, 1884.—William Carruthers, F.R.S., Vice-President, in the chair.—The following were elected Fellows of the Society:—The Hon. F. S. Dobson, W. A. Haswell, Geo. W. Oldfield, Dr. G. W. Parker, M. C. Potter, T. J. Symonds, W. A. Talbot, and J. H. Tompson.—Mr. W. T. Thiselton Dyer exhibited:—(1) Examples of leaves of *Sagittaria montevidensis* under different modes of cultivation, the changes thus induced as regards size and general facies being most remarkable, so much so that they might be deemed widely separate genera. The small leaves were from a plant raised from seeds collected in Chili by Mr. J. Ball, F.R.S., and sent to Kew in 1883, and grown in a pot half submerged in the *Nymphæa* tank. The enormously large leaf and spike were those of a plant raised from seeds, ripened at Kew, and sown in spring (1884). When strong enough the plant was planted in a bed of muddy soil, kept saturated by means of a pipe running from the bed to the *Nymphæa* tank. (2) A special and peculiar instrument called a "Ladanisterion," from Crete, it being a kind of double rake with leathern thongs instead of teeth, and used in the collecting of gum Labdanum, a drug now dropped out of modern pharmacy. The instrument in question was procured for the Kew Museum by Mr. Sandwith, H.M. Consul in Crete. (3) A collection of marine Algæ from West Australia, brought to this country by Lady Broome.—A paper was read by Dr. Francis Day on the relationship of Indian and African fresh-water fish-fauna. In this communication the author refers to certain papers of his, read before the Society on previous occasions, but he more particularly deals with the differences shown between his own statements therein and those subsequently given by Dr. Günther in his "Introduction to the Study of Fishes." Dr. Day is inclined to believe that in the consideration of Indian fish distribution there seems a possibility that certain marine forms, for example, the Acanthopterygian *Lates*, the Siluroid family Ariinæ, and others have been included among the fresh-water fauna by Dr. Günther, whereas fresh-water genera, such as *Ambassis*, several genera of the Gobies, *Sicydium*, *Gobius*, *Eleotris*, &c., have been omitted from the fresh-water fauna of India by Dr. Günther. Thus Dr. Day attempts to show that there may be less affinity between the African and Indian regions, so far as fresh-water fishes are concerned, than there is between his restricted Indian region and that of the Malay Archipelago. He adds that of 87 genera found in India, Ceylon, and Burmah, 14 extend to Africa, 44 to the Malay Archipelago, whereas out of 369 species only 4 extend to Africa and 29 to the Malay Archipelago.—On the growth of trees and protoplasmic continuity, was a paper by Mr. A. Tylor, giving his experiments in the curvature assumed by branches, particularly those of the horse-chestnut. He pointed out that the terminal bud is constantly directed upward, but is straightened out at a later stage of growth. Further, he found that terminal buds, when directed by being tied against a tree-trunk or plank, invariably turned away from the obstruction irrespective of the incidence of light. When the growing points of neighbouring branches were turned directly towards each other, they mutually turned aside or one stopped growth. Some co-ordinating system was necessary to enable the parts to act in concert, and he attributes this to a continuity of the threads of protoplasm.—A paper was read on *Heterolepidotus grandis*, a fossil fish from the Lias, by James W. Davis. The author describes the specialities of this form, and remarks that the genus had been instituted by Sir Philip Egerton for certain forms closely related to Lepidotus, but differing in their dentition and scaly armature. The *H. grandis* has interest, among other things, in the attachment of the dorsal and anal fins with the series of well-developed interspinous bones, in the peculiar arrangement of the articular apparatus of the pectoral fins, and in the heterocercal form of the tail.

Chemical Society, December 18, 1884.—Dr. Russell, F.R.S., in the chair.—The following gentlemen were elected Fellows:—W. P. Ashe, Sir B. V. S. Brodie, Bart., J. F. Ballard, W. Briggs, M. T. Buchanan, W. G. Brown, H. M. Chapman, W. H. Eley, J. Frost, T. P. Hall, H. J. Hodges, H. Jackson, F. Johnson, J. D. Johnstone, G. F. Kendall, C. W. Low, F. M. Mercer, P. C. Porter, V. E. Perez, A. Rickard, K. B. B. Sorabji, R. B. Steele, H. Smith, E. G. Smith, C. Thom, W. Tate, P. C. Thomas, T. Wilton, J. H. Worrall, W. C. Wise, W. H. Wood.—The following paper was read:—Chemico-physiological investigations on the cephalopod liver and its identity as a true pancreas, by A. B. Griffiths. The author could not detect any bile acids or glycogen in this organ, but a ferment obtained from it by glycerine converted starch paste into sugar, and formed from fibrin, obtained from the muscular fibres of a young mouse, leucin and tyrosin, the latter body giving, with a neutral solution of mercuric nitrate, a red precipitate. It was announced that at the next meeting, January 15, Prof. Thorpe would read a paper on the atomic weight of titanium, and that Dr. Frankland would give a lecture in February on chemical changes produced by micro-organisms.

Royal Microscopical Society, December 10, 1884.—Rev. Dr. Dallinger, F.R.S., President, in the chair.—Mr. Crisp exhibited Dr. Cox's radial microscope, a simplified form of Mr. Wenham's stand.—Mr. J. Mayall, jun., exhibited a new stage which he had devised, in which the thin upper plate was abolished and a frame to hold the slide substituted, which is not liable to flexure.—Mr. Crisp also exhibited Ward's eye-shade, Bausch's adapter for a spot lens, and Kain's mechanical finger.—Mr. Rosseter's paper on the gizzard of the larva of *Corethra plumicornis* and its uses, and one of Mr. G. F. Dowdeswell, on variations in the development of a Saccharomyces, were read and discussed.—A communication was read from Dr. Cox, the President of the American Society of Microscopists, expressing scepticism as to the possibility of making sections of diatoms so thin as those claimed by Dr. Flögel, as recently published in the Society's *Transactions*.—Mr. Parsons exhibited the hydroid form of *Limnocodium Sowerbii*, the fresh-water Medusa which he had found in April last at the Botanic Gardens, Regent's Park.—Dr. Zenger's method of mounting diatoms so as to show both sides was explained, and some mounts exhibited.—Mr. Cheshire gave a *résumé* of his paper on some new points in the anatomy of the bee. It has long been known that the queen bee, in common with many insects, stores the spermatozoa she receives from the male in a small sac, which is called the spermatheca. A long chain of evidence has also satisfied entomologists that in some way these spermatozoa are transferred to those eggs which are to be converted into undeveloped females known as workers, but the manner of this fertilisation has not hitherto been demonstrated. By carefully dissecting out a spermatheca with its attachment to the oviduc[illegible] unbroken, and then by needle-knives cutting through the trach[illegible]a which incloses it completely, the spermatheca and its valve m[illegible] b[illegible] isolated. It is then seen to be accompanied by a long dou[illegible] gland having a centrally-placed duct, provided with a sphin[illegible]r muscle near its junction with the aperture of the spermathec[illegible]. The spermatheca itself carries a sphincter and three muscl[illegible] [illegible]o to aid and

one to antagonise its action. The glandular secretion acts as a vehicle for carrying the spermatozoa, as liberated, towards the oviduct. Another gland, previously unknown, now adds its secretion, and serves to bring the spermatozoa into proper separation from each other. The common oviduct is not a simple tube, as formerly supposed, but carries in its centre a pouch of delicate membrane, and very like the recurved tail of a lobster. Two muscles, having for their especial purpose the direction of the egg in transit to the ovipositor, carry the egg, if a worker is to be produced, into this central pouch, and bring it into contact with the spermatic fluid, when a spermatozoon enters its micropyle. If a drone or male is to be produced, it takes a lower path in the right or left oviduct, and a side path to the ovipositor, and so avoids the pouch and escapes fertilisation. Siebold's theory of parthenogenesis in the bee is thus anatomically demonstrated to be accurate.—Dr. Van Heurck's paper on the resolution of *Amphipleura* into "beads" was read, and gave rise to a long discussion.—The meeting resolved to send a contribution to the memorial now being raised in America to the late R. B. Tolles, the eminent optician.

Royal Meteorological Society, Dec. 17, 1884.—Mr. R. H. Scott, F.R.S., President, in the chair.—Mr. C. H. Cotton, Mr. S. A. Jolly, L.R.C.P., and Rev. C. J. Taylor, M.A., were elected Fellows of the Society.—The following papers were read:—On the reduction of temperature means for short series of observations to the equivalents of longer periods, by Dr. Julius Hann, Hon.Mem.R.Met.Soc. The author has recently carried out an investigation into the climate of the Alpine districts of Austria, and in doing so he has endeavoured to reduce the monthly and annual means of all the temperature observations from the districts in question during the interval from 1848 to 1880, and in some places to 1884, to the mean for the thirty years' period 1851 to 1880. In this paper Dr. Hann describes the methods he adopted to reduce observations at mountain stations for short periods to the equivalents of longer periods.—The diversity of scales for registering the force of wind, by Charles Harding, F.R.Met.Soc. The object of this paper is to call attention to the confusion that exists in the systems in use by various countries for registering wind-force, whether instrumentally or otherwise, and to show the need of action for improvement.—Report on the phenological observations for the year 1884, by the Rev. T. A. Preston, M.A., F.R.Met.Soc. The salient features of the weather during the period embraced in this report, viz. October 1883 to September 1884, were: the mild winter, the cold April, the hot August, and the long period of drought, which at the end of September began to be seriously felt. The general effects on vegetation have been: the prolonged existence of many of the autumn species, the great loss of wall-fruit, the failure of bush fruits, the plentiful supply of strawberries as long as they lasted, but the time was short; the good hay harvest, although it was light in quantity; the good corn crop, the unusually plentiful potato crop, and the great abundance of wild fruits.

EDINBURGH

Royal Society, December 15, 1884.—Mr. Robert Gray, Vice-President, in the chair.—Dr. Sang read the first part of a paper on the theory of the tides.—Mr. J. T. Cunningham gave a communication on the nature and significance of the structure known as Kupffer's vesicle in teleostean embryos.—Prof. Turner discussed the relation of the alveolar form of cleft palate to the incisor teeth and the intermaxillary bones.—Mr. T. Andrews, F.C.S., gave a paper on the apparent lines of force on passing a current through water.

Royal Physical Society, Dec. 17, 1884.—B. N. Peach, F.R.S.E., F.G.S., President, in the chair.—The following communications were read:—On *Loligopsis* and allied genera, by W. E. Hoyle, M.A. (Oxon), F.R.S.E., &c. The author reviewed all the species which have at various times been referred to the genus *Loligopsis*, and indicated the different genera to which they should be relegated; the genera *Leachia*, Lesueur, and *Taonius*, Steenstrup, were fully characterised; *Desmoteuthis*, Verrill, was considered, and shown to be synonymous with *Taonius*.—Mr. Hoyle also exhibited, with remarks, a specimen of *Strongylus contortus* (Rud.).—Mr. J. R. Henderson, M.B., of the Scottish Marine Station, Granton, read a communication on additions to the fauna of the Firth of Forth. Specimens were exhibited of forty-five species new to the district, including the following:—*Astrorhiza limicola*, *Halecium* sp. (probably new), *Ascandra variabilis*, *Tomopteris* sp., *Nymphon hirtum*, *Corophium tenuicorne*, *Nyctiphanes* (*Thysanophoda*) *Norvegica*, and *Podopsis Slabberi* (new to Britain).—Mr. F. G. Pearcey explained a method of hardening friable and decomposed rocks, sands, clays, &c., so that sections may be made of them for microscopical purposes. During the cruise of the *Challenger*, he said, there was obtained a large collection of oceanic deposits, whose structure could not be accurately determined without making transparent sections. On account of their extreme friability this was found impossible by the usual methods, and it was therefore necessary to find a mode of rendering them hard and compact. After many experiments and much labour, a method was devised which had proved successful, and which would be found of great service to mineralogists, geologists, and others, in the investigation of soft rocks. It consisted in the introduction of a foreign substance to cement the grains together, and so render the material capable of being cut into sections. The substance used for this purpose was a solution of gum copal in ether, the ether being evaporated after the material had been soaked in the preparation, and the residuum carefully dried. Mr. Pearcey minutely described the various processes to be followed, and exhibited specimens illustrative of the results obtained. Mr. Hoyle spoke of the necessity of having mud and ooze examined by the polariscope, and bore testimony to the value of the method of doing this, which was due to Mr. Pearcey's patience and perseverance.—A note on the breeding of the Marsh Tit (*Parus palustris*, L.) in Stirlingshire during the present year (1884), with exhibition of nest and eggs, was read by Mr. William Evans, F.R.S.E.—On abnormal dentition in a Dingo (*Canis dingo*), specimen exhibited, by Andrew Wilson, L.D.S.—Mr. A. Gray exhibited, with remarks, a live specimen of the Water Spider (*Argyroneta aquatica*) from Luffness Marshes.

DUBLIN

Royal Society, Nov. 17, 1884.—Section of Physical and Experimental Science.—Prof. J. Emerson Reynolds, F.R.S., in the chair.—After an introductory address by the chairman the following communications were read:—Notes on the aspect of the planet Mars in 1884, by Otto Boeddicker, Ph.D., communicated by the Earl of Rosse, F.R.S. The notes are accompanied by thirteen drawings of the planet, representing the following longitudes of Mars' central meridian:—(1) 12°·6 (March 23), (2) 24°·9, (3) 28°·3 (March 22), (4) 38°·0 (March 23), (5) 73°·0 (March 17), (6) 137°·8 (March 10), (7) 261°·8, (8) 267°·4 (April 2), (9) 279°·4 (April 1), (10) 286°·7, (11) 303°·2 (February 24), (12) 307°·6 (April 1), (13) 317°·4 (February 24). When compared with Schiaparelli's charts they admit of the identification of the following spots:—*South:* Sabæus Sinus, Deucalionis Regio, Thymiamata, Margaritifer Sinus, Auroræ Sinus, Mare Cimmerium, Hesperia, Syrtis Minor, Syrtis Major, and a trace of Œnotria or Japygia; *North:* Lacus Niliacus, Nilus, Alcyonius Sinus, Astapus; on the *disk-middle* traces of these canals: Gehon, Indus, Hydaspes, Ganges, Cyclopum, Phison, Euphrates. Sketches Nos. 1 to 4 show when the markings in longitude 10° lie on the disk-middle, the sp–nf direction of Deucalionis Regio, but when they lie near the preceding limb the sf–np direction of Thymiamata prevails so considerably that the angular shape of the two Sinus Sabæus and Margaritifer may be entirely overlooked, and only the one or the other direction perceived and ascribed to them. Lacus Niliacus is seen interrupted on Nos. 1 and 4, so as to resemble its appearance on Schiaparelli's chart of 1882; and Nilus is seen double on No. 13—which makes it probable that a trace of Schiaparelli's gemination of lines was perceived at Birr Castle. During the time between Nos. 7 and 8, Syrtis Minor became much darker, and Syrtis Major became visible; this, as it cannot be due to the planet's rotation, is probably due to changes in its own atmosphere. Alcyonius Sinus appeared much darker than either in 1879 or 1881. Sketch No. 5, which at time of drawing was considered difficult but fairly good, does not show any spots capable of certain identification. A comparison with other drawings of the same period may explain this.—On the volatilisation of zinc from German silver alloys at high temperatures, by A. R. Haslam; communicated by Prof. C. R. Tichborne. Alloys of known composition were heated in a current of hydrogen, and weighings taken at intervals of one hour. The chief loss in weight was found to take place in the first hour, and the loss was greatest in the alloys that were poor in nickel. The author concludes that nickel has the effect of retarding the volatilisation of the zinc.—On the analogy between heat and electricity, by Prof. G. F. Fitzgerald, F.R.S. It was

pointed out that the analogy, as usually drawn between heat and electricity, namely, to liken temperature to potential and quantity of heat to quantity of electricity, is not the true analogy, inasmuch as the product of temperature and quantity of heat is not of the nature of energy, and that the true analogue of quantity of electricity is quantity of entropy. In this case a non-conductor of electricity is a non-conductor of entropy, *i.e.* a non-conductor of heat. As the quantity of electricity is the same at all parts of a circuit, and as it requires a perfect heat-engine to transfer entropy from one temperature to another undiminished, conductors must be of the nature of perfect heat-engines. It was further pointed out that a molecular structure of ether similar to that of a gas could be assumed, the motions of whose molecules might be polarised in such a way by differences of temperature that, although no heat was conducted, it would be thrown into a state of stress which would explain electrostatic phenomena. It was explained that this was a step beyond that made by Maxwell in his "Electricity and Magnetism," where he avoids any hypothesis as to how electric displacement produces mechanical stress. The author stated, however, that the object of this communication was not to bring forward this doubtful hypothesis, but, by drawing attention to this analogy between heat and electricity, to prevent the danger at present imminent of its being supposed that the analogy between electric displacements and the motions of an incompressible fluid is the only analogy possible, and of this mere analogy being consequently mistaken for a likeness.—Howard Grubb, F.R.S., exhibited a star map photographed by the Rev. T. E. Espin.

Natural Science Section.—V. Ball, F.R.S., in the chair.—On a new species of *Halcampa*. This is the first recorded example of the genus in Ireland, and it proves to be a new species, for which the name *H. Andresii* is proposed. It was found at Malahide, Co. Dublin.—Mr. G. Y. Dixon exhibited a living and some preserved specimens of *Peachia hastata* from Dollymount Strand, Dublin Bay. This is the first Irish locality.—The Chairman exhibited geological maps of Canada and of the United States, with specimens of Laurentian rocks and minerals.

Paris

Academy of Sciences, December 22, 1884.—M. Rolland, President, in the chair.—On a new method of measuring the heat of combustion of carbon and organic compounds, by MM. Berthelot and Vieille. The present paper is limited to the determination of the heat of combustion for cellulose (coton) and the various carbons used in the manufacture of gunpowder.—Description of a microscopic element by means of which it may be possible to determine the various groups of Cynthiadæ, by M. de Lacaze-Duthiers.—Remarks on the "Cours d'exploitation des Mines," presented to the Academy by M. Haton de la Goupillière.—Remarks on the volume of the *Connaissaance des Temps pour* 1886 and the *Annuaire pour* 1885, presented to the Academy in the name of the Bureau of Longitudes by M. Faye.—Note on the indeterminate equation

$$x^2 - Ky^2 - z^n,$$

by M. Maurice d'Ocagne.—On the thermodynamic potential and the theory of the voltaic pile, by M. P. Duhem.—Description of a diffusion photometer, by M. A. Crova.—Note on the heat of combustion of the ethers of some acids of the fatty series, by M. W. Louguinine. The author's experiments lead to the general conclusion that the heat of combustion of an acid is perceptibly equal to that of the ether of the same acid, less the heat of combustion of the corresponding alcohol, regard being had to the number of molecules of alcohol in reaction.—Note on the α-ethylamidopropionic acid, by M. E. Duvillier.—Observations on the optic activity of cellulose in connection with M. Béchamp's recent communication, by M. Alf. Levallois—On the cutaneous anæsthetic action of the hydrochlorate of cocaine, by M. J. Grasset. It is shown that the hypodermic injection of 0·01 gr. of the hydrochlorate of cocaine produces in man a sharply limited zone of cutaneous anæsthesis without general phenomena, and with slight local consequences, although lasting long enough to perform a certain number of surgical operations.—Influence of the variations in the centesimal composition of the air on the intensity of the respiratory functions, by M. L. Frédéricq.—On the spinal bone in the series of vertebrate animals, by M. A. Lavocat.—Note on the constitution of the reticulate rhizopods, by M. de Folin.—On the Acari dwelling in the quill of birds' feathers, by M. E. L. Trouessart.—On the existence of phanerogamous Asterophyllites, by MM. B. Renault and R. Zeiller.—On the Kersanton formation in the Croisic district, Loire Inférieure, by M. Stan. Meunier.—On a phenomenon of crystallogeny in connection with the fluorine of the Cornet rock near Pontigabaud, Puy-de-Dôme, by M. F. Gonnard —Results of the analysis of the masses of boiled beetroot, made with a view to determining the quantity of chloride of potassium and nitrate of potassium contained in it, communicated by M. H. Lepley. The quantity of these salts in 100 kilogrammes of root was found to be :—

	Max. Gr.	Min. Gr.	Mean. Gr.
Nitrate of potassium	342	43	131
Chloride of potassium	217	65	143

Berlin

Physical Society, Nov. 21, 1884.—Prof. Neesen reported on a case of magnetisation produced by a stroke of lightning, the distribution of which had been examined by a former pupil of the speaker. The lightning had struck the clock of a church tower, and so strongly magnetised it that it was only by great force that the pendulum could be moved from its position of rest, while the clock had to be taken to pieces and the magnetised iron parts demagnetised by means of heat. The most strongly-magnetic part was a U-shaped piece of cast-iron, the two perpendicular and downward-directed legs of which bore the edges for the pendulum. The distribution of the magnetism in this piece of iron was as follows :—Not far from the lower ends (at about a third of the height) was a neutral point on both sides, the inferior piece on one side being north polar, on the other side south polar. On the side having the north pole, south polar magnetism was found above the neutral point, extending above the middle line and beyond, so as to take in about the upper third of the other leg. Thereupon followed an upper neutral point, between which and the lower neutral point of this side was found north polar magnetism. The two lower neutral points were the spots where the two legs of the U-shaped piece of iron were connected by a horizontal iron pin. Other effects of the lightning were not to be found either in the clock or on the church tower.—Prof. Neesen further produced a galvano-plastic high relief of iron, of a dull silver-gray, which in fineness of detail far surpassed the productions of the silver galvano-plastic art. The method by which this was produced was still kept secret by the manufacturer.—Prof. Lampe communicated some interesting results arrived at by his pupils in exercises in calculation. One problem was to calculate the attraction of a homogeneous mass of certain form on a material point of its surface, if the attraction of the same mass in globular form on the pole was equal to 1. The calculation was first made for a flattened ellipsoid, in which the attraction on the polar point was known to be greater than 1. With increase of oblateness the attraction increased up to a maximum, for which the magnitude of the attraction and the eccentricity of the meridian curves were calculated. After this maximum the attraction abated, with further increase of oblateness, and the eccentricities of those meridian curves were calculated for which the attraction was equal to 1, as also of those for which it was equal to 0·5. Similar calculations were made for the elongated ellipsoid. In this case the attractions on the polar point became continually less, and only the eccentricity of the meridians was calculated, in which the attraction was equal to 0·5. Another exercise was to calculate the attraction of a circular cylinder on the middle point of a terminal plane, when the relation of the radius, r, of the terminal plane to the height, h, changed. In this case, too, with a certain relation of h to r a maximum of attraction was found, which was more than 1 but yet less than the maximum in the case of the flattened ellipsoid. After this maximum the attraction declined as well with increasing h as with increasing r, and the two relations of h to r, in which the attraction was equal to 1, were found. Finally, in the case of the circular cones, the attraction on the apex was calculated, and here, too, the maximum was determined, being, however, less than 1, and the cone was determined in which the attraction on the apex was equal to the attraction on the centre of the fundamental plane.—Prof. Landolt described a simple contrivance used by him for recovering the products of sublimation. A test tube, of glass in the case of bodies easy to sublime, of platinum in the case of bodies difficult to

sublime, was closed at the top by a stopper through which passed two small tubes, one reaching to the bottom, the other coming out below the stopper. The first small tube was connected with the condenser, and by this means the tube became permanently cooled. The cold tube was let down into the vessel in which the substance to be sublimed was being heated, and the products were obtained on the outside of the little tube, from which they could be easily removed. By a platinum tube in the platinum retort the speaker received molybdenous acid crystals, and, by the heating of lime, microscopic lime crystals.—Prof. Landolt further described an arrangement of a sodium lamp for a polarimetric apparatus in which a uniformly bright flame was produced, and he also showed a theodolite with a glass scale, which could be read by transmission of the incident light, thus facilitating observation.

Physiological Society, November 29, 1884.—Prof. Waldeyer exhibited a microscope-stand which he found very practicable, both for the ease and security with which it enabled a microscope to be turned in any direction, and for the way in which it allowed the use of any system of lenses.—Prof. Du Bois-Reymond spoke on the difficulty of determining the blood pressure in the capillary vessels, and discussed the method he had adopted in his lectures for the presentation of correct views on this matter. As was known, the blood-pressure in the capillary vessels had hitherto been determined by placing a small glass plate on a spot of skin and then estimating the pressure that was necessary to render this spot void of blood. By this method, however, the elasticity of the inter-capillary tissues was left out of account, and the results were therefore vitiated, so far as the determination of the pressure in the capillaries was concerned. The exact state of the case, which it was difficult for any experimental examination to come at, was, in the first place, able to be determined only under ideal conditions. In the current of an incompressible and inexpansible fluid through a system of pipes under a given propelling force the rate of current was always in inverse proportion to the cross section, while, with the distance of the propelling force, the pressure abated at a rate proportionate to the resistance, *i.e.* it sank more rapidly in narrow, and more slowly in wide, tubes. If a tube were widened by splitting it into two branches of equal calibre, the proportions between lateral section, rate of current, and pressure remained the same. If, on the other hand, the bore became as large again as before, the rate of current sank to a half, while the pressure decreased but little. If, again, a capillary network were intercalated into the system of pipes, the rate of current fell only in proportion to the enlargement of the total cross section; the pressure, on the other hand, sank considerably on account of the resistance presented by the capillaries, and the curve of pressure showed a very steep decline in relation to the abscissæ of the zero-line. If the capillaries again merged into simple tubes, the cross section became less, the rate of current proportionally greater, while the pressure again sank but slowly. In the middle of the capillary system the pressure, in accordance with known laws, amounted to half the initial pressure. In the circulation of the blood the cross sections of only the larger arteries and veins were known; the cross section of the capillary system was unknown. Under the ideal conditions, however, which formed the basis of the above scheme this cross section might be calculated from measurable rates of current. Suppose the rate of current of the blood in the capillary vessels equal to 0·8 mm. per second, and that in the aorta equal to 500 mm. per second, then the current in the latter was 625 times as swift as that in the capillaries, and the cross section of the whole capillary system must be 625 times as large as that of the aorta, or the diameter of all the capillaries was twenty-five times as large as the diameter of the aorta. The curve of pressure sank slowly in the arterial system. In the capillaries the great resistance required a very considerable difference of pressure, and the curve of pressure sank, therefore, very considerably; to sink more slowly in the veins down to beneath the abscissa line, *i.e.* the pressure in the veins in the neighbourhood of the heart became negative. In the middle of the capillary system the pressure, in accordance with this view, was equal to half the pressure in the ventricle. Should the arteries in consequence of the contraction of their smooth muscle-fibres become narrower, the point where the pressure in the capillaries was equal to half the heart's pressure shifted nearer to the arterial system. If, on the other hand, contractions or obstructions occurred in the veins, this point came closer to the venous system. Such a presentation of the case gave a view of the conditions of cross section and pressure in the capillaries, and offered a basis for experimental investigations. A scheme of the same kind might be applied to the system of lymphatic vessels, for which the average pressure in the blood capillaries must be taken as starting pressure.—Prof. Fritsch related an optical phenomenon he had perceived during the microscopical examination of certain objects, a phenomenon he described as due to monocular stereoscopic vision. Certain pictures, in particular those of the transverse section of the principal nerves of the electric organ, made a decided impression of a funnel-shaped depression such as was otherwise obtained only in the binocular contemplation of the well-known stereoscopic figures. It was especially easy for him to receive this impression on moving his eye from side to side. By producing the arrangement he had referred to at the next sitting of the Society, he would ascertain whether other eyes received the same impression of the picture.

VIENNA

Imperial Academy of Sciences, December 4, 1884.—On the scientific usage of orthogonal axonometers, by C. Pelz.—On the mechanical theory of electricity, by T. Tanuschke.—On energy and coercive state in the magnetic field, by G. Adler. On the consumption of some foods in the intestinal tract of man, by H. Malfatti.—Contribution to a knowledge of some hydroproducts of cinchoninic acid, by A. Weidel and K. Hazura.—On the action of the sun-spectrum on the haloid compounds of silver, and on the raising of their sensibility to some parts of the spectrum by colouring-matters and other substances, by T. M. Eder.—Computation of the orbit of the planet Russia 232, by N. Herz.

December 11, 1884.—On morin, part 2, by R. Benedikt and K. Hazura.—Communication on the determination of nitrogen, by G. Czeczetka.—Studies on the compounds prepared from animal tar; part 5, on collidine, by H. Weidel and B. Pick.

December 18, 1884.—On deformation of the plane of light-waves in the magnetic field, by E. von Fleischl.—Contributions to the explanation of cosmic-terrestrial phenomena; part 2, on aurora borealis, by T. Unterweger.—On Kjehldahl's method for determining nitrogen, by G. Czeczetka.—On central eclipses of the sun of the twentieth century, by E. Mohler.

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THURSDAY, JANUARY 8, 1885

SCIENCE AND SURGERY

FROM the earliest ages, the functions of the brain have been a fascinating study to cultivated minds, and the greatest intellects of all ages have occupied themselves in attempting to solve its difficult and complicated problems. With the ancients this was a favourite pursuit, and engrossed the thoughts and talents of their most illustrious philosophers. Owing to the absence of exact methods of scientific observation and experiment, the conclusions on this subject were for many centuries of a purely speculative character, and the errors and fallacies thus deduced have been handed down and accepted till comparatively recent times. Modern investigations have, however, thrown a flood of light on the question, and although much still remains in the dark, the former obscurity has of late years been brightly illumined by the lamp of science. The accumulated clinical experience of ages had left knowledge on the cerebral functions in a state of confusion and uncertainty, and owing to the obvious difficulties and complications associated with disease, the results, however significant, were at best imperfect. That the brain should be subjected to direct physiological experiment was, until modern times, never attempted. During the last generation only has the practicability of this been demonstrated, and numerous observers have, by direct operations on the brain substance of animals, arrived at new conclusions as to its functions, and greatly revolutionised our ancient conceptions on the subject. Evidence has also been given against the *noli me tangere* theory, and abundant proof has been adduced of the fact that the brain may be handled, irritated, or partially destroyed without necessary danger to life. One of the latest developments of this method of investigation has been the discovery of those centres in the cortex which preside over voluntary motion, which have been, more especially by Prof. Ferrier, differentiated and localised with great precision. This important knowledge has been arrived at by an extended series of experiments conducted on living animals, in which, by observing the several effects of stimulating or destroying limited areas of their brains, the different functions of these special localities have been determined. A topography of the cerebrum has thus been constructed, in which the various faculties have been mapped out, but these, unlike the illogical visions of the phrenologists, have stood the test of sceptical criticism and rigid experimental inquiry. Researches of a purely scientific nature, carried out only with the object of elucidating truth and advancing knowledge, without immediate prospects of material gain, have in this instance led to most important and useful practical advantage. Armed with the knowledge acquired on animals in the laboratory, the physician has been enabled to utilise at the bedside the conclusions thus arrived at for the service of human beings. Clinical experience combined with morbid anatomy had already enabled the medical man to suspect the presence of disease in the brain, but as to its precise locality he was formerly in doubt. Now, however, guided by the recent revelations of physiology, he is enabled to predict the position in a large number of cases with great certainty and precision. Evidence of this is afforded by the proceeding adopted in a case of disease, notice of which has lately appeared in the medical papers. It appears that a man presented a series of symptoms which enabled Dr. Hughes Bennett to diagnose a tumour of the brain, that it involved its cortical substance, that it was probably of limited size, and that it was situated at a certain definite spot. The skull was trephined over the suspected region; there a tumour was found and removed. On recovering from the immediate effects of the operation the patien was and continued for three weeks in a satisfactory condition. He was perfectly intelligent, his functions, except for certain defects of motion caused by the disease, were normally performed, and there was an absence of all the distressing symptoms from which he had formerly suffered and from which he must necessarily soon have succumbed. Unfortunately, at the end of this time a complication, incident to all serious surgical operations, supervened, from which the patient ultimately died. The unhappy termination of this particular case does not in any way detract from the importance of the principles which it involves. It still remains a signal triumph of diagnostic accuracy, a precision mainly attained by exact experimental research. It is, moreover, further proof that by utilising this improved knowledge the surgeon may not only remove disease from the brain, but that he may do so without necessary shock or risk to the nervous system, and that the procedure, under modern antiseptic precautions, need not be attended with greater danger than may follow any other severe surgical injury. This interesting and instructive case will doubtless inaugurate a new era in medical practice, for although this particular individual has succumbed to measures adopted to avert his otherwise certain death, the experience thereby gained is sufficient to encourage further efforts in a similar direction which may prove beneficial to others. In the Marshall Hall oration of last year Prof. Ferrier remarked, "There are already signs that we are within measurable distance of the successful treatment by surgery of some of the most distressing and otherwise hopeless forms of intercranial disease, which will vie with the splendid achievements of abdominal surgery." He further added, reflecting on the success which had attended brain operations on animals, "I cannot but believe that similar results are capable of being achieved on man himself." That distinguished physiologist cannot but feel gratified that his prophetic words have been partially realised.

DE BARY'S "VEGETATIVE ORGANS OF THE PHANEROGAMS AND FERNS"

Comparative Anatomy of the Vegetative Organs of the Phanerogams and Ferns. By A. De Bary. Translated by F. O. Bower and D. H. Scott. (Oxford: Clarendon Press, 1884.)

IN 1861 a plan was drawn up in Germany to provide a series of hand-books or text-books on botany, which should treat of the science as it existed at the time; four of these books were completed, De Bary's "Vergleichende Anatomie der Vegetations-organe der Phanerogamen und Farne" (published in 1877) being one of them. This

book, as is well known, proved to be a masterpiece of industrious research, accurate treatment of facts, and critical sifting of details; its influence soon became apparent, not only on the best teaching and text-books of our time, but also on those engaged in original research in various directions. This marked influence was not confined to Germany, but affected the teaching in this country also; and some of us were so fortunate as to come under that influence before more antiquated methods of treatment had rendered difficult the task of receiving the new impressions.

Mr. Bower and Dr. Scott have now prepared a translation of this treatise, and those best acquainted with the original will be foremost in congratulating them, not only for having placed the work in the hands of English workers and students, but also for the manner in which it has been accomplished.

In commenting upon the plan of the book, it should be borne in mind that the basis of classification is anatomy, and anatomy only, and this accounts for many peculiarities in the mode of treatment.

The introduction sets this forth clearly, and shows the kind of difficulties to be avoided in the scheme. Students will gain by carefully reading this able introductory portion, which contains an admirable account and criticism of the relations of the tissues to the meristem from which they are derived, and the vexed question as to the best mode of classifying the systems of tissue in mature parts. The great difficulty of course is in the case of what Sachs terms the "fundamental tissue"—*i.e.* the tissue which remains after the dermal tissue and fibro-vascular system have been removed. De Bary finds it necessary to cut this up into several forms and systems of tissues, as was to be expected from the mode of treatment. Sachs has lately again maintained that on the whole the "fundamental tissue" is best regarded as one system. This and other discussions as to the relative value of systems of tissues certainly owe much to the point of view started from, and it is not easy to see how De Bary could avoid the further dissection of the larger systems of tissues.

As matter of fact he is constrained to adopt six chief forms of tissue, various groupings of which constitute the systems of tissues. These are: (1) Cellular tissue (epidermis, cork, and parenchyma); (2) sclerenchyma; (3) secretory structures; (4) vessels (this word is *Tracheæ* in the German, and "vessels" does not express its intended meaning accurately); (5) sieve-tubes; (6) milk-tubes (*i.e.* laticiferous vessels). Intercellular spaces forming the subject of an appendix. This preliminary classification, as would be expected, presents difficulties here and there, and it will be seen that the structures designated "secretory" afford exercise for the utmost ingenuity in classifying them anatomically.

Having laid down the lines along which the plan of the work is to run, so far as these forms of tissue are concerned, De Bary then proceeds to review and criticise the views held as to the differentiation of the various groups of tissues from definite layers or portions of the meristem of the growing-point. Hanstein's classification into dermatogen, plerome, and pleriblem is well known, as is also the calyptrogen of Janczewski. We cannot here enter into details, but must refer the student to this excellent summary, merely stating that the facts do not allow of Hanstein's classification being extended to all the cases, though it must be admitted as true for very many. Nor have later investigators succeeded in establishing a system of classification of the tissues comparable to that of the animal embryologist. This of course complicates the matter, and accounts in part for the plan followed in the second part of the book, which treats of the arrangements of the forms of tissue referred to above, and of the changes in their primary arrangement brought about by secondary changes, *e.g.* growth in thickness, &c.

In Part I. the first chapter deals with cellular tissue, the portion concerned with the epidermis and its structure being particularly interesting and important. De Bary's account of the stomata has long been known, but many facts relating to those peculiar forms known as water-pores or water-stomata will be new to the student unacquainted with the original. The description of the cuticle and cuticularised layers of the outer walls of the epidermal cells, and the facts as to the occurrence of wax on their exterior are very important, and must afford the basis for all future work on these subjects. A striking example of De Bary's critical power and ability to deal broadly as well as in detail with large series of facts are evident in his remarks on those troublesome organs known as glands. It may well be doubted whether we shall ever have a satisfactory classification of the various "secretory structures" on anatomical grounds solely; it must be admitted, however, that the most satisfactory account of these bodies, as a whole, is given in the present book. De Bary limits the term gland to epidermal secretory organs—all others are to have definite names implying their different position, &c. This necessitates the separate treatment of reservoirs of secretions, and laticiferous vessels as contrasted with epidermal or dermal glands on the one hand, and intercellular spaces which contain secretions, &c., on the other; the difficulties arising from various causes are in part met and discussed, but there are some still outstanding.

Having treated of the forms of tissue in the first seven chapters, Part II. of the book commences with Chap. VIII. The first section (Chaps. VIII. to XIII.) is concerned with the primary arrangement of the forms of tissue. The vascular bundles are here dealt with in great detail from two points of view: (1) with reference to their course or distribution in the stems, leaves, and roots; and (2) as regards their structure. The first aspect of vascular bundles is almost unknown in England, and most teachers have ignored it altogether. It is important, however, and although they must not be ranked or compared with structures occurring in other organisms, we must not forget that the supporting and conducting systems of a higher plant are represented by its wood and tracheæ, while its sieve-tubes have equally important duties to perform. This being so, there is no less reason for studying the course and distribution of the vascular bundles (and the same remark applies to laticiferous vessels, reservoirs of secretion, and even strands of sclerenchyma) in a plant, than for tracing the distribution of the various conducting, supporting, and secreting tissues and organs in a higher animal. Already the investigations promise to bear fruit, as witness Koch's descriptions of the course and endings of sieve-tubes in the leaves, and also the various points of anatomy which throw light on

the discussion as to the ascent of water in wood. No doubt it is too early to anticipate where these researches may lead; meanwhile every botanical student should learn the course of the vascular bundles in several typical plants, say, among others, *Lathyrus*, *Clematis*, a Palm, *Tradescantia*, a Fern such as *Aspidium*, and *Equisetum*. This should be done not only with reference to the distribution of these important structures, but also in order that the study of transverse sections may become something more than the impression of a pattern on the memory, as it too often is.

The bearing of these matters on the older views which confined the attention too much to the typical palm-type for the Monocotyledons, and to a few restricted examples of Dicotyledonous stems is obvious.

Some very important points exist also with reference to the structure of the vascular bundles, a matter which should be studied as De Bary studied it, in connection with the above. Students are seldom led to understand that the terminations and interconnections of vascular bundles often differ considerably from the enlarged portions of the bundles, or "bundle-trunks," as the translators term them. The classification of vascular bundles into collateral, concentric, and radial has become better known of late years; but even now too little attention is paid to the subject of the structure and development of the vascular-bundle system in roots. This should be all altered now, for it is difficult to imagine better guidance for teachers and students than is afforded by the work under review, and specialists will not be able to dispense with it.

Want of space prevents our entering further into some other weighty matters in this portion of the work. No doubt some difficulty will be felt by the uninitiated with regard to De Bary's treatment of the subject of sclerenchyma. The key to the difficulties consists in the fact that however convenient it may be to regard the sclerenchymatous fibres of the "hard-bast" as part of the "fibro-vascular" bundle, sclerenchyma may be regarded as a form of strengthening tissue which recurs in various positions, and may therefore be treated separately—that which occurs as strengthening tissue associated with the vascular bundles being called bast-fibres, and treated as part of the bundle (which then becomes "fibro-vascular") for no other reason than because it is convenient, and the name is an established one. Simple as the matter is when understood on anatomical grounds, we fear that confusion will still ensue from want of care in apprehending the state of the case; this will be due to no fault on the part of the translators, however, for the portions of the book dealing with these particulars leave little to be desired.

The second section of Part II., treating of the secondary changes produced in the arrangement of the tissues by growth in thickness, forms a part of the book which has had much influence on text-books since it was written. The account of the growth in thickness by means of a cambium zone is excellent, and should be carefully studied by every botanist. The concluding portions of the book are in some respects more adapted for the specialist than for the ordinary student, but we do not advise the latter to neglect them on that account; on the contrary, much of the foregoing information becomes clearer when contrasted with the more abnormal processes observed in the forms there treated of. The facts are somewhat more isolated, however, and can only become important in proportion as the earlier parts of the book are understood; moreover, work remains to be done among the more anomalous forms.

Enough has been written to show that no botanist will be able to dispense with the work, and it only remains to point out one or two faults in the translation, and perhaps to mention a few trivial matters which might have been put better. Such phrases as "a numerous group of large . . . cells (p. 21), "the morphologically lower leaf-surface" (p. 319), and "quite a few rows" (p. 372), are somewhat harsh, and result from the close rendering of the original; objection may also be taken to such employment of compounds as "air-and-water-containing" (p. 210) and "many-layered, chlorophyll-containing parenchyma" (p. 226). It is true that students of science who read much German find less difficulty from the recurrence of such forms in English than might be expected, but many will regard them as serious blemishes which render the book more difficult to read. *Commelyna* (p. 40) becomes "*Commelina*," subsequently (p. 270 *e.g.*) we believe the former is correct, the latter being the German spelling. "Equiseta" and "Gramina" (*e.g.* p. 213), and "*Orobanches*" (p. 384) are not elegant. The reference to Fig. 207 on p. 467 is wrong, that figure concerning *Cytisus*. No doubt the misprint stands for 209.

The translators are responsible for several terms which will be new to English botany, and we must admit our indebtedness to them for attempting to introduce definite English equivalents for such terms as "*Bündel-stämme*," "*Holz-stränge*," "*Neben-zellen*," and "*Ersatz-faserzellen*." Whether "bundle-trunks," "ligneous bundles," "subsidiary cells," and "intermediate cells" respectively will be generally accepted as the equivalents in English remains to be seen. Personally we regard them with favour, as serviceable representatives of terms which have their uses. However, we can do no more here than congratulate the translators on having placed one of the most important scientific works of the day in the hands of British botanists in a satisfactory form; and we no less heartily congratulate those botanists who have been debarred from reading it in the original German on the rich store so well placed before them.

OUR BOOK SHELF

The Solar System. By Ernest R. G. Groth, M.D. Pp. 34. (London: John Bale and Sons, 1884.)

THIS book contains a very imperfect account of the nebular hypothesis of Laplace and Kant, with certain variations which must be incorrect, because they violate mechanical principles, and with certain speculations which are valueless because they are based on mere imagination.

The author does not realise the relativity of force and motion, for on p. 9 he asks: "If a body be acted upon by no force, why should it move at all?"

On p. 11 we learn how axial rotation originates when a nebular mass revolves orbitally about a centre of force. The explanation depends on the different orbital motion of the nearer and further parts of the nebular planet. As far as this goes it should, when properly applied, give us

negative rotation in the planetary mass, but we here find it used to explain positive rotation.

The author states that the planets are "hurled" or "projected" from the sun: but he does not see that even if some *deus ex machinâ* were just to prevent the otherwise inevitable fall back into the sun, the eccentricity of the orbit must be very large instead of very small.

On p. 14 we find that "it is moreover manifest that each individual planet must from time to time have had its orbit greatly extended" by the reduction of the sun's mass on the birth of each planet. It is, however, the fact that the orbit of Jupiter, for example, would be scarcely appreciably altered were this process reversed, and were all the planets interior to Jupiter either suddenly incorporated with the sun or annihilated.

On this same page we learn "that in a system of particles revolving about a fixed centre, the momentum, that is the sum of the *products of the mass of each into its angular velocity* (sic ital), and the distance from the common centre is a constant quantity." Does it not follow that when a planet moves in an elliptic orbit, so that its distance from the centre of force is *not* constant, there is *not* constant moment of momentum? What then becomes of the generally accepted conservation of areas in elliptic motion?

The fanciful explanation of the inclinations of the planetary orbits, and of the obliquity of the planetary axes, need not be stated; but we observe that "the northern hemisphere, being that which contains more land than the southern, was directed away from the sun at the time it (the earth) was projected away from that body," and this, together with the context, shows that the northern hemisphere is here supposed to be heavier than the southern. The fact of course is that the hemisphere antipodal to Spain, by its greater density, attracts the sea away from the Spanish hemisphere and leaves our half of the globe drier than the other half.

The asteroids arise from the rupture of a planet X, which in cooling had been converted into a vast Rupert's drop (p. 21): "What a scratch does for the Rupert's drop, the pull occasioned by Jupiter's attraction effects for the doomed planet: the thin crust is rent, and forth in a thousand different directions fly his meteoric fragments."

On p. 23 we find that the Glacial period was a sudden catastrophe, and that the fleeing mammoths were caught by the intense cold and frozen to death.

At the end of the work the author emphasises the analogy, long ago pointed out, between the system of Saturn and his satellites and of the sun and his planets.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Apospory in Ferns

My note in Nature (p. 151) on the remarkable mode of reproduction in ferns discovered by Mr. Druery has brought me two friendly communications, both of which deserve a few words.

Dr. Vines reminds me that in an article on the proembryo of *Chara*, published in the *Journal of Botany* (1878, pp. 355–363), he had suggested that this structure is homologous with the spore-bearing generation (sporophore) in mosses. His arguments in favour of this view are extremely ingenious, if not wholly convincing. At any rate, if his theory is correct, the sporophore in this plant remains in a rudimentary condition, "producing no spores, but giving rise to the oophore by the lateral budding from one of its cells." Hence, he concludes, "we may speak of this plant as 'aposporous,' using a word which is symmetrical with the term 'apogamous,' applied by De Bary to those ferns in whose life-history no process of sexual reproduction occurs." We must give Dr. Vines, I think, the credit for first clearly defining in terms the aposporous condition as the converse of apogamy, though the phenomenon was first observed by Pringsheim in the Moss in 1876 (*Monatsb. d. Königl. Akad. der Wiss. zu Berlin*, 10 Juli, 1876). At any rate, according to Dr. Vines's view, what is only an occasional abnormality in the moss and the fern is the normal state of things in *Chara*.

The distinguished Italian botanist and traveller, Signor Odoardo Beccari, points out to me that the structures now known as archegonia and antheridia had been observed in *Salvinia natans* as early as 1834 by Savi. I had not overlooked the paper in which priority for the discovery was claimed for Savi by Marcucci (*Nuovo Giorn. Bot. It.* i. pp. 198–208). But the brief chronological table which I gave in my note had reference only to ferns proper (*Filices*) and not to the heterosporous group of the *Filicinæ*—the *Rhizocarpeæ*.

W. T. Thiselton Dyer

Frost Formation on Dartmoor

On the afternoon of Tuesday, December 30, 1884, about 3 p.m., we were on Yes Tor, near Okehampton, long reputed the highest point of Dartmoor, though it is understood that the new survey now in progress brings out the neighbouring summit of High Willhayse a few feet higher. For about 200 feet below the Tor the ground was frozen hard. It was free from snow, the weather having been fine for several days, but everything was white with hoar-frost. On the rocks of the Tor this frost assumed a form of singular beauty, and, we think, not a common one. At least, neither of us can match it in either English or Alpine experience, or remember to have seen an account of anything like it.

On the first impression the walls of the granite masses which make up the Tor looked as if covered with feather-work exquisitely wrought in congealed snow. The feathers (to call them so provisionally) overlaid one another as thickly as real plumage, and ranged in length from one inch or less to five or six inches, being smaller on the flat and recessed surfaces of the rock, and larger on the jutting and exposed ones. They lay almost wholly on the eastward, that is (as the weather then was, and for some days had been) the windward side of the Tor; and their tips pointed roughly in that direction, with the sort of uniformity one would get by laying down a great number of branches or feathers all one way. It is impossible to describe the richness of this natural decoration. Only the finest Oriental workmanship could come near the effect produced by the infinite and minute variety which this tapestry of frost-flakes combined with one dominant form and direction. Something of the same type, but far less perfect, may be seen on a mussel-covered rock at low water. Still more curious was the appearance of the Royal Artillery flagstaff which surmounts the Tor. It was loaded (on the windward side, like the rocks) with a solid fringe of the same formation, but in longer and thicker flakes. We judged it to be full six inches deep, and at first thought it must be supported by a string attached to the staff, but there was, in fact, no string at all.

Close examination of the individual flakes revealed great beauty of structure. They were mostly of an elongated lozenge shape, like a squared spear-head, but sometimes more like tongues of flame. Their contours and delicate surface-markings showed them to be built up of laminæ, into which they were easily resolved by a slight blow. These laminæ again split up into crystalline needles parallel to the longer diameter of the flake, that is, in the line of the imaginary spear-shaft. Only photography or very careful drawing (for neither of which had we the means, time, or skill) would clearly convey the details of the formation.

As to the physical explanation, we conceive that the process must have been set up by a thin layer of mist (probably in a very finely-divided state to begin with) drifting against the rock and freezing to it. Successive accretions brought in the same way would gradually produce the display of giant hoar-frost which we have imperfectly described. The details of form and structure we leave to be considered by those who have made a special study of ice-crystals. But it seems fairly obvious that for such a result there must be a concurrence of many favouring conditions. There must be a clear frost without snow, which of

course would destroy and obliterate these delicate forms. There must be a steady set of wind, enough and not too much of it, and the air must be saturated with moisture in a certain state of molecular division. Some of these data might, perhaps, with the resources of a modern laboratory, be settled by experiment. If the experiment succeeded it would be an extremely pretty one.

F. POLLOCK
C. C. COLLIER

Woodtown, Harabridge, South Devon, January 2

Krukenberg's Chromatological Speculations

MY attention has been lately called to a recent publication of Dr. C. F. W. Krukenberg, entitled "Grundzüge einer Vergleichenden Physiologie der Farbstoffe und der Farben," in which some remarks and misstatements occur relative to my work, which in self-defence I feel I am not justified in letting pass without comment.[1]

(1) With regard to his observations on the colouring matter obtained by me from the integument of certain invertebrates, and which I called "*dermochrome*," I do not see why I should have left it unpublished because three-quarters of a year before he had found that "lipochromes" were widely distributed in the animal kingdom. I found that lutein and hæmatoporphyrin occurred together in a peculiar combination, and said so. I suppose the offence lies in the name "lutein." This word must now, according to Krukenberg, be got rid of, because he has chosen to call it "lipochrome." Perhaps, after all, "lutein" is more appropriate, as it does not mean fat pigment; for this pigment occurs where there is no fat, *e.g.* it is not derived from fat in the *Corpora lutea.* Krukenberg bases his conclusions mainly on the reactions of the solid pigment with nitric and sulphuric acid and iodine, but I hope to have something to say on this point before long.

(2) Krukenberg maintains that the chlorophyll of cantharides is due to that in the intestines of these beetles. He committed himself to this theory at an early stage of his investigations, *before he knew of Pocklington's observations*; but after seeing the abstract of my paper read at the meeting of the British Association at Southport in 1883, in which I called attention to Pocklington's work, he makes it appear that he knew all about it long ago, which is not fair. Now since Pocklington and I obtained chlorophyll from the *elytræ* of these beetles, I do not think the above theory can be accepted, except it can be proved by Krukenberg that the intestine ramifies through the *elytræ*.

(3) Krukenberg says that *I* "*assume*" that the chlorophyll spectrum seen by me in the integument of the larva of *Pieris rapæ* is due to chlorophyll in that situation, whereas it is really due to chlorophyll-holding masses in the intestine. I never did "assume" anything of the sort. I said distinctly at Southport that it was due to food chlorophyll in the intestine, as could easily be proved, for on emptying the intestine the chlorophyll band could no longer be seen. This must be a wilful misrepresentation, as he acquired the knowledge of Pocklington's work from the same abstract in which my explanation occurs.

(4) He further says that my knowledge of the literature of the subject must be great when I assume that he has confused "*anthea green*" and "*diatom yellow*," whereas I said distinctly "it would appear, according to Geddes" (see Geddes' paper in NATURE, vol. xxv. p. 303) that he had confused them. I may, however, now observe that his supposition that the colouring matter of the yellow cells of *Anthea* is what he calls a "hepatochromate" can easily be disproved; all that is necessary is to add a little caustic potash or caustic soda to its alcoholic solution when the colouring matter becomes completely altered; for this reason any deductions drawn from Krukenberg's "saponification method" in this case are of little value.

(5) Krukenberg says he had found "chlorophyll-like stuffs" in the livers of animals before I had done so. I am sure this statement is open to question, as his spectra are not accurate representations of what is seen in solutions of *enterochlorophyll.* In most cases only one or two bands are shown by him, and the other proofs brought forward by me are not given in the accompanying text. If his own test for a true chlorophyll be accepted, I can, and hope shortly to, show that animal chlorophyll is a true chlorophyll, and can be obtained in the crystallised state, and the crystals are the same as those obtained by Dr. Hansen, an abstract of whose work will be found in this journal (vol. xxx. p. 224).

(6) It is further suggested that the darkening of the bands in solutions of "echinochrome" (a pigment whose spectrum I have lately described) produced by adding sulphide of ammonium, is caused by precipitation of certain ingredients. This is not the case. The same appearance is produced by stannous chloride and other reducing agents. I have, however, lately succeeded in isolating this pigment, and can confirm my former results. I hope to publish shortly an account of the spectra of its solutions.

(7) Krukenberg makes it appear that I have said that the green gland of the crayfish contains hæmoglobin. I never said so. The statement was this: "In the green gland of one crayfish a band was detected which, I think, was due to reduced *hæmatin*, but it was absent in the second specimen examined." Perhaps Krukenberg thinks that hæmoglobin and hæmatin are the same.

(8) I am made responsible for the statement that the eye of the house-fly contains hæmoglobin; I never said so, nor can I agree with Krukenberg that it gives no band. It gives a band at D, and is not similar to the pigment of the eye of Cephalopods, which he assumes to be the case.

I leave the inferences to be deduced from the above statements to others; but I must protest against Krukenberg's treatment of my work. It is at least satisfactory to know that my experience is not unique, as other English, German, French, and Italian workers receive an equally fair treatment by Dr. Krukenberg.

Wolverhampton, Dec. 23, 1884 C. A. MACMUNN

[1] The papers in which my observations on the subjects referred to were published are:—*Proc. Roy. Soc.*, 1883 (No. 226); *Proc. Birmingham Philos. Soc.*, vol. iii., 1883; and *Brit. Assoc. Reports*, 1883.

Our Future Clocks and Watches

I WOULD suggest, as a modification of "R. B.'s" suggestion in NATURE (p. 80), that the striking of the clocks on the twenty-four system might be varied at each quarter of the day, so as to indicate the time without so much striking. Thus, 1 (a.m.) to 6 might be indicated by the usual method; 7 could be indicated by two strokes, a pause, and one stroke; 8, by two strokes, a pause, and two strokes; and so on to 12; 13, by three strokes, a pause, and one stroke; and so on to 18; 19, by four strokes, a pause, and one stroke; and so on to 24, which being thus indicated by only ten strokes would require less effort to count, and make less noise than by the old system. Dials might be modified in the same way. Instead of twelve there would be only six divisions around the dial, and the quarter of the day could be indicated by a small wheel revolving behind a peephole, or by a third hand (which could be very short) revolving once a day over four divisions or quadrants, marked on the dial near the axis. People, however, would seldom or never need to look at this. Thus would be done away all the objections urged by Harmer. The hour-markings are only conventional signs any way, and it does not make any especial difference in what way the hours are indicated if people would only accustom themselves to the use of the twenty-four hour system in speaking and writing.

H. H. CLAYTON

Ann Arbor, Michigan, December 20, 1884

MODE OF RECKONING TIME AMONGST VARIOUS PEOPLES

THE recent Prime Meridian Conference at Washington has attracted attention to the methods employed at various periods, and amongst peoples in different stages of civilisation, to reckon time. Dr. Robert Schram, on October 24, read an interesting paper on this subject before the Geographical Society of Vienna, in which he dealt chiefly with the Chinese, Hindoos, and the Jews. The three units of measurement given by Nature herself are the rotation of the earth on its own axis, the revolution of the moon in its orbit, and that of the earth around the sun; these are wholly independent of each other, and neither is an aliquot part of the others. But from the earliest times efforts have been made to connect these units; there is the attempt to balance all three, which gives the luni-solar year, or those to connect the day with the course of the sun or of the moon, from which we get the solar or lunar year. In the earliest times the most complicated of these, the luni-solar year, in which it

was sought to connect and equalise all three units, was the one most in use. This is comprehensible when we recollect that now we want to fix single days as far back or in the future, as we wish, and that therefore this form of year appears complicated to us; but in primitive times it was really the most simple form of all, for the sun and moon relieved man of the trouble of reckoning days, and in the months and seasons wrote large on the face of Nature herself the hours and minutes, if we regard the days as seconds. A glance at the heavens or at the surrounding vegetation must have told primitive man the most that he wanted to know of the passage of time, and have supplied the deficiencies of his calendar. How the luni-solar year came direct from Nature herself, and also how it was to be taken as an approximate method only, may be seen in the most ancient form of the Jewish year, which was so regulated that the feast of Passover should be celebrated when, during full moon the barley, which was required as an offering, was ripe, and it must be in the first month of the year, which was then Nisan. Twelve months then were counted from this; but if at the end there was no prospect that the barley would be ripe in fourteen days, a second month, Adar, was simply intercalated, and the new year began with the next new moon. But when an exact and rigid measurement of time is required, this form of year is simply perplexing. The three main types existing down to our own day of the luni-solar year are the Chinese, the Hindoo, and the Jewish years, and each of these is treated by Dr. Schram in turn.

With the Chinese, as in the case of almost every luni-solar year, every month begins with the new moon, and the first month is that in which the sun is in Pisces, the second that in the course of which it enters Aries, and so on. But if the sun in the course of a lunar month does not enter into a new zodiacal sign, it is regarded as an intercalary month, and receives the number of the previous month, with a mark of distinction. In this way months of 29 and 30 days succeed each other, but there is no fixed rule for this succession, nor for the place of the intercalary month of the year, nor for the succession of the intercalary years, and as the commencement of all the months and years have to be astronomically calculated, the whole year is somewhat uncertain and fluctuating, for a few minutes, or even seconds, may alter the beginning of a month by a day, and cause a difference in the intercalation of a month. It is difficult, too, to say according to what tables the astronomical data in the more ancient periods were calculated, so that it would be a matter of much uncertainty to transfer a date into another chronological system, if it were not for the circumstance that the Chinese from the most remote antiquity employed a cycle of 60 days for reckoning the days, much as we employ the week, without regard to the movements of the sun or moon. The uncertainty of the year which prevents the fixing of a precise day two or three years hence has rendered the calendar an indispensable *vade mecum*. The compilation of the calendar has thus become a work of vast importance, which the State has taken on itself and committed to the care of an Imperial mathematical tribunal, presided over by a royal prince. When the work is periodically completed it is presented with great pomp to the members of the Imperial family and to the members of the Government. The years are counted among themselves in two ways, employed simultaneously. The official year is the fourth, fifth, or as the case may be, of the reign of the Emperor, although even this is subject to alteration; while there is also a series of cycles of 60 years each, every individual year having a distinguishing name of its own. These years are named on a system universal in Eastern Asia, which is based on a combination of one name from ten *Kan* or "roots," with one from twelve Chi or "branches." This peculiar method of forming a cycle by the combination of two smaller cycles is found among the Japanese, Manchus, Mongols, and Thibetans, all of whom use the 60-year cycle formed from the cycles of 10 and 12 years; also among the Aztecs a cycle of 52 years, formed from one of 4 and 13 years, is found, which led Humboldt to believe in an infusion of Asiatic ideas in Mexico. The years are more rarely given in a 12-year cycle, each having the name of some animal; this is also universal in Eastern Asia.

The luni-solar year amongst the Hindoos was based on a sidereal solar year, the twelve months of which, though of unequal lengths, were of fixed duration down to the minutest fraction of time. Thus the solar month Chaitra was 30 days, 20 hours, 21 minutes. 2 seconds, and 36 thirds. The day, however, had 60, not 24 hours. The year began with the new moon immediately preceding the commencement of the solar year. But if two lunar months began in the same solar month, the first was intercalated. In case no lunar month fell in the solar month, then that year would lose one of its ordinary months, but at some other part of its course it would have two intercalary months. Every month among the Hindoos has its proper name. The new moons with which they commence are calculated with great exactness and according to inflexible rules, so that it is easier to go back than in the Chinese system. Still there is a difficulty, on account of the various systems employed at different early times. The fact, too, that the day is the thirtieth part of the lunar month, and thus shorter than the natural day, introduces an element of doubt into calculations of this nature. The years are reckoned from 0; the first year of the era is 0, the second 1, the third 2, and so on, so that the number given to any one year is that of the preceding one. The 60-year cycle is also employed, but it is not formed from the combination of two cycles; each year has its own name. It is based on the course of Jupiter and contains five revolutions of that planet; but as the twelfth part of a revolution of Jupiter is only 361 days, 1 hour, 36 minutes, while the sidereal year contains 365 days, 15 hours, 31 minutes, 31 seconds, 6/3rds, a new re-arrangement is from time to time necessary, and a year of the cycle has to be periodically omitted. There are three separate rules for calculating when this is to be done. As eras are employed by the Hindoos for reckoning years, the cycle is of less importance. These eras are themselves divided into cycles of varying lengths. The current era is the Kali Yuga, or Iron Age; 4985 years of it have already passed, so that it is little younger than the era of the creation; but according to Hindoo notions it has still a vast course to run, and it is an age of which not only the beginning but also the end is precisely known. It is to last in all 432,000 years, and the earlier periods run as follows:—

Kali Yuga, or Iron Age	432,000 years
Dvapara Yuga	864,000 ,,
Treta Yuga, or Silver Age	1,296,000 ,,
Krita Yuga, or Golden Age ...	1,728,000 ,,

These four form a so-called Maha Yuga, or Great Age, of 4,320,000 years. Of these Maha Yugas there are 71, giving 306,720,000 years, *plus* a twilight of 1,728,000, give 308,448,000 years, being the length of a patriarchate. There are fourteen of these patriarchates, or 4,318,272,000 years, which, with a dawn of 1,728,000 years, give 4,320,000,000 years, being a kalpa or æon of Hindoo chronology. But the ages extend beyond this, for an æon, or kalpa, is only one day of Brahma; his night is of the same length, and 360 such days and nights form a year of his life, which lasts 100 of these years. The present age is the Kali Yuga of the 28th Great Age of the 7th patriarchate of the first æon of the second half of the life of Brahma, who is therefore 155,521,972,848,985 years old at present. But Brahma's whole life is only a wink of Siva's eye!

Another form of the luni-solar year is that of the Jews.

In its later and more developed form this does not rest on observation or on fluctuating astronomical calculations, but on a comparatively simple cycle, based on a fixed month and year. Everything is settled beforehand: the intercalary month and year are inserted at stated periods. The system is the nineteen-year metonic cycle: nineteen solar years give 235 lunar months, in the course of which the 3, 6, 8, 11, 14, 17, and 19th years are intercalary, a month being inserted between Adar and Nisan. The months are successively 29 and 30 days long, the times of each being settled. But simple as this appears, various circumstances have conspired to render Jewish chronology very complicated. Such are the inclusion of small fractions of time in calculating the new moon for the new year, and the frequent religious precepts dislocating the arrangement for the beginning of the year; so that there are years of 353, 354, 355, as well as those of 383, 384, and 385 days. The years were reckoned regularly from the creation of the world, which is placed on October 7, 3761 B.C.

Having thus discussed the forms of the luni-solar year still in existence, Dr. Schram refers to those formerly in use by various nations. The Greeks also employed the cycle of nineteen lunar years, with seven intercalary months in every cycle, thus approximating to nineteen solar years. The months were of 29 and 30 days, and the years were reckoned by Olympiads of four years each. Subsequently Calippus brought the metonic cycle closer to solar periods by the omission of one day in every 76 years.

Among many peoples the modes of reckoning time do not deserve the name of a system. The Otaheitans used the changes of the moon, and the growth of the bread-fruit; the Makha Indians on Cape Flattery the moon, and the seasons, of which latter they distinguished two, the cold and the warm; the Muysca Indians, according to Humboldt, had 37 lunar months in their cycle, and 20 of these cycles formed a larger one. Where there were no religious festivals connected with the new or the full moon, people gave up the luni-solar year altogether, and adopted the solar year only, confining themselves to bringing day and night into connection with it as far as possible, and paying no regard to the moon's course. It was soon found that the solar year was approximately 365 days in length, and this we find first in the year of the ancient Egyptians. They divided their solar year of 365 days into 12 months, each of 30 days, to which they added 5 supplementary days. The years were counted according to the reigns, and the Canon of Ptolemy is a chronological table giving the commencing years of the various kings. The same form of year is found amongst the Persians, with the difference that the supplementary days were added to the 8th and not to the 12th month. Their months had names, not numbers, and their years were reckoned from the accession of Jezdegird, an era from which the Persians, especially in some parts of India, still count their years. It is remarkable that so inexa_t a year, originating so long ago, should have existed through centuries down to our own day, although its incorrectness was early recognised. The Egyptians, for whom the time of the rising of the Nile, at the ascent of Sirius, was of great importance, noticed soon that the occurrence came later and later in their year, and that if the Dog-star rose one year on New Year's Day, four years later it was the second day, eight years the third, and so on. On this they based the Sothis, or Dog-star period of 1461 Egyptian years, in the course of which Sirius rose successively on every day of the year. Then came the knowledge of the year of 365¼ days, which is tolerably exact, and of this there are several forms of years. In Egypt the change to the more exact reckoning was accomplished in a simple way. The months of 30 days and their names were retained, but to three of them in succession 5 days were added, and every fourth year the supplementary day gave 6 days to 1 month. This form of year is called the Alexandrian, and it is used at present by the Copts in connection with the Diocletian era. This year of 365¼ days was carried to Rome by Cæsar, where the method of counting time was in disorder; and henceforth in Rome the year was of this length, the months consisting of different numbers of days, in place of the Alexandrian supplementary days. This system forms the foundation of our calendar, and is the well-known Julian reform. A peculiar form of the year of 365¼ days was that of the ancient Mexicans. Their solar year consisted of 18 months of 20 days each; at the end of the year 5 supplementary days were added, and at the end of 52 years, 13 more days. The old Icelandic year also was very peculiar. The unit there was the week of 7 days, and in order to make the year an exact number of weeks, there were 12 months of 30 days each, with only 4 supplementary days at the end. Then at the end of 6 or 7 years another week was added, so that the ordinary year consisted of exactly 52 weeks, while the leap year had just 53. The year of 365¼ days was, however, a little too long, and in about 128 years there was an error of 1 day. In the Julian as well as in the Alexandrian system an improvement was found. The former was reformed by Pope Gregory XIII., not so much in the form of the year, as in the method of intercalating. In every year divisible by 100 the intercalary day was to be omitted; but in those divisible by 400 it was to be introduced. Shah Shelal Eddin reformed the Alexandrian system by an ordinance that when the intercalation had taken place every fourth year for 7 or 8 times, the next time it should not take place till 5 years had elapsed. In other words every seventh or eighth leap year was to be the fifth, not the fourth year. Thus there would be 7 leap years in 29, or 8 in 33 years. The last attempt to reform the Alexandrian system was made during the French Revolution, partly with the object of introducing the decimal system into time reckoning, partly also to get rid of all reference to Christianity or any other form of confession. The year which was then introduced was based on the Alexandrian year, but the intercalation was different. The months, consisting of 30 days each, received the names of Vendémiaire, Brumaire, Frimaire, Nivose, &c., and were divided into 3 decades of 10 days each, which took to some extent the places of the weeks. The intercalation was not cyclical, but based on exact astronomical calculations, and it was decreed that the first Vendémiaire should commence with the day on which, according to exact Paris time, the sun entered the autumnal equinox. It is easy to see that this method of intercalating could not exist long without reform, even if there were no independent objections to it, for it has all the defects of the Chinese year. The years were counted from the proclamation of the Republic.

The lunar year is the last portion of his subject treated by Dr. Schram. All that can be said about it occupies but a small space. Here a balancing of the days and of the course of the moon alone is required, the movements of the sun, and the change of the seasons being wholly disregarded. The Turks and Arabs use this year, and indeed it is common all over the Mohammedan world. The year has 12 lunar months; but the Turkish year can hardly be called a year in our sense of the term, with its regular succession and return of the seasons. In the course of 33 years the beginning of this year ranges over the whole of the seasons. If a Turkish festival comes one year in the depth of winter, 16 years later it will be at midsummer. The 12 months have 30 and 29 days: in the leap year the last month has 30 instead of 29 days. In a cycle of 30 years, the leap years are the 2nd, 5th, 10th, 13th, 15th, 18th, 21st, 24th, 26th, and 29th years. The years are counted from the flight of Mohammed from Mecca to Medina.

THE LATE JOHN LAWRENCE SMITH

THE following information relative to Dr. John Lawrence Smith of Louisville, U.S.A., who died on October 12, 1883, in his sixty-fifth year, is abstracted from a sketch of his life and work, prepared by his friend, Prof. Silliman, at the request of the American Academy of Sciences.

John Lawrence Smith was born near Charleston, South Carolina, on December 17, 1818. "Even as a child of four years, and before he could read," says his friend, Dr. Marvin, "he was familiar with the operations of simple arithmetic; at eight he was prepared for the study of algebra, and at thirteen was studying the calculus." At the age of seventeen (1836) he entered the University of Virginia, and for two years devoted himself to the study of chemistry, natural philosophy, and civil engineering. For twelve months after leaving the Univeristy he acted as assistant engineer on the Charleston and Cincinnati railroad, but relinquished the post with a view to the study of medicine. While still a student in Charleston he made known to chemists (1839) the use of potassium chromate as a reagent for distinguishing between the salts of barium and strontium; and in the same year he published a paper on a new method of making permanent artificial magnets by galvanism.

In 1840 Mr. Smith proceeded to his medical degree, submitting as a graduation thesis an essay upon the compound nature of nitrogen. His father being a well-to-do merchant, Mr. Smith was able to continue his medical studies; for this purpose he travelled to Europe, and spent his winters at Paris under Dumas, Orfila, Pouillet, Despretz, Becquerel, Dufrénoy, and Elie de Beaumont, and his summers at Giessen under Liebig. In 1842 appeared his elaborate paper on "The Composition and Products of Distillation of Spermaceti," probably the first extensiue work in organic chemistry undertaken by an American chemist. In 1843 he began medical practice, though chemical research was more congenial to his taste; and, in fact, during the next four years, he found time to contribute important work towards the improvement of analytical methods in chemistry. At this time he also acted as assayer for the State of South Carolina, studying its marls, ores, and cotton-bearing soils. Able reports on these subjects led to his selection by the Secretary of the United States as professional adviser of the Sultan of Turkey in the matter of the introduction into that country of American methods for the culture of cotton. "Finding, on his arrival in Turkey, that an associate proposed to inaugurate the cultivation on a plan doomed to failure, he was about to return to America, when he received from the Turkish Government a commission to explore the mineral resources of the country. He entered at once, with his customary zeal and intelligence, upon the work, and in the four years of his residence in the Sultan's dominions, in spite of many vexatious restrictions, he opened up natural resources which have ever since added an important item to the revenues of the Porte. His memoir on emery (1850) was equally important, both from a scientific and economic stand-point. Before his observations 'On the Geology and Mineralogy of Emery,' made in Asia Minor, little was known of the mode of occurrence of this useful mineral. The island of Naxos had long been almost the only locality, and the supply from this source was limited and the price excessive, and no geologist had found an opportunity of studying the mineral associations of emery or its relations to corundum. Smith's sagacity as an observer, his originality in discussing new methods of examination, his patience and conscientious fidelity in executing his work, are all conspicuous to the student of this memoir. From the study of the mineralogical associations in which he found the emery of Asia Minor, he felt convinced that the search for like associations elsewhere would be rewarded by the discovery of emery or corundum. With this view he addressed Prof. Silliman, requesting him to test the correctness of his observations upon known localities of corundum in the United States. The associate minerals were immediately found and reported. Later on, Smith had the opportunity of seeing the accuracy of his views demonstrated at the emery mine of Chester, Hampden County, Massachusetts, which Dr. Charles T. Jackson had discovered by use of the key of its associate minerals, as suggested by Smith, the locality having been before regarded only as an iron mine."

Weary of the life he led in Turkey, and irritated by the obstacles thrown by the Turkish officials in the way of any real mineralogical exploration of the country, Dr. Smith resigned his appointment in 1850, and returned to America. He married in 1852, and in the same year succeeded to the chemical chair in the University of Virginia, which he retained for one year; it was at this time that he published the method of determining the alkalies in silicates which is now in general use. From 1854 to 1866 he was Professor of Chemistry at Louisville, but finding the restraints of a professorship distasteful, he, in the latter year, resigned the chair, and afterwards devoted his scientific work almost wholly towards the investigation of the chemical nature of meteorites, publishing nearly fifty papers on that subject. Having been successful in collecting illustrations of no less than 250 falls, he was very anxious that the collection should be kept together, and with this view he negotiated its sale for 2000*l*. to Harvard College; the news of the conclusion of the purchase only reached him on the last day of his life. Since his death the sum received from Harvard College has been presented by his widow to the American Academy of Sciences for the institution of a "J. Lawrence Smith medal for researches on meteoric bodies."

"Dr. Smith's personal character possessed a charm which won all who came within the sunshine of his genial nature. His sturdy manliness and integrity was combined with an almost feminine gentleness. During the years of the Civil War, while his affiliations and life-long associations were inseparably united with his native south, he deplored the sad conflict with a spirit bowed as under a personal sorrow; but none heard a word from him which partook of bitterness or animosity, and no shadow passed across the path of his old friendships."

Dr. Smith had no children, but he founded and amply endowed an orphan home in Louisville, his adopted city.

For the last two or three years he was in delicate health, owing to a chronic affection of the liver; and on August 1, 1883, a severe attack of the disease compelled him to take to his bed, from which he never rose again. Without acute suffering he passed peacefully away on Friday, October 12, at three in the afternoon.

By his direction, his funeral was of the most simple character and without an eulogy. His life closed as he had lived, peacefully, with uncomplaining endurance of suffering. His last words were: "Life has been very sweet to me; it comforts me. How I pity those to whom memory brings no pleasure!"

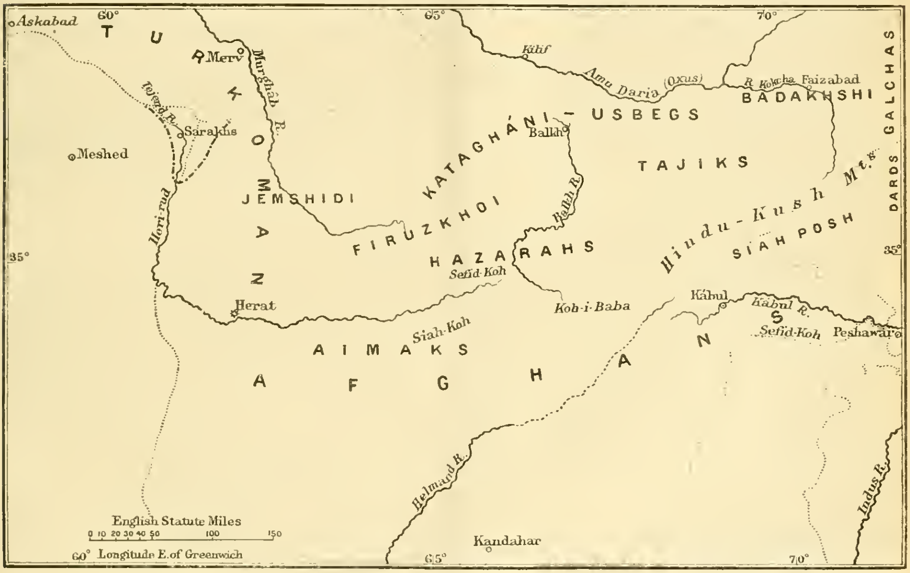
THE NORTH AFGHAN BORDER TRIBES

IN a paper on "Afghan Ethnology," published in NATURE, January 22, 1880, a comprehensive survey was given by this writer of all the varied racial elements in Afghanistan. Here it is proposed to deal exclusively and somewhat more fully with the northern peoples lying along and about the new boundary line proposed to be laid down between the now conterminous Anglo-Indian and Russian empires. Were the importance of ethnological studies understood or recognised by British statesmen, it would be needless to insist upon an accurate knowledge of the tribal relations in this border-land

before determining the future line of demarcation between the two States. As matters stand, nothing can be done beyond supplying a few authentic data, which, if not too late, may possibly help our Boundary Commissioners to appreciate the gravity of the situation.

Politicians of eminence have in recent times spoken flippantly of a great and consolidated Afghan people, one in origin, speech, usages, national aspirations, in friendly alliance with the British *ráj*, destined to constitute a formidable bulwark of the Indian Empire against the further encroachments of the northern Colossus. Those who have conjured up this pleasant vision, and shaped their policy in the belief of its realisation in our days, are doubtless well meaning persons; but they are not practical men of business, dwellers rather in dreamland than sober inhabitants of this planet. Afghanistan is not the home of one, but of many peoples, differing widely in race, language, customs, in some cases even in religion and political institutions; nor are the materials at hand by which these heterogeneous fragments could be welded into a single body politic for many generations to come.

A mere glance at the accompanying sketch map will suffice to show that the Afghan race proper, since the death of Nadir Shah (1747) heir to the former Persian masters of the land, nowhere even approaches the northern frontiers, except in the Herat district towards the north-west. Notwithstanding their great elevation, the mountain ranges stretching from the Hindu-Kush, through the Koh-i-Baba and parallel Safed-Koh and Siah-Koh chains westwards to Khorasán, constitute neither an ethnical, a political, nor even a complete physical parting line between the Afghan plateau and the Turkestan lowlands. The Hindu-Kush itself doubtless forms a distinct "divide" for the waters flowing north to the Oxus, south to the Indus basin. Further west, also, all the head streams of the Murgh-áb, or River of Merv, have their



sources on the northern slope of the Safed-Koh, probably the Paropamisus of the ancients. But here the mountain barrier is completely pierced by the Heri-rud, which takes its rise south of the Koh-i-Baba, and, after flowing a long way west between the Safed-Koh and the Siah-Koh, trends northwards beyond Herat to the Turkestan steppe. Politically, also, the rampart is broken all along the line, both slopes from Kashmir to Persia being claimed and hitherto recognised as integral parts of Afghan territory. Thus the whole of Afghan Turkestán, of Badakhshán, and the more remote north-eastern provinces of Wakhán and Shugnán, are comprised within the Aralo-Caspian hydrographic system.

A clear idea of these geographical features is necessary to a right understanding of the racial conditions in this extremely intricate ethnological region. From before the dawn of history constituting a natural parting line between Irán and Turán, it has, nevertheless, been so repeatedly crossed and re-crossed by the contending floods of migration and conquest, advancing now from the north, now from the south, that throughout the historic period it appears to have always been occupied by peoples both of Mongolic and of Caucasic stock. At present the former are found mainly in the western section, between the meridians of Kábul and Herat, the latter thence eastwards to the Pamir and Indus, each on both slopes of the Iranian escarpment between the 34° and 40° parallels. Of the two the Caucasic appears to be the aboriginal, the Mongolic the intruding, element; and by many ethnologists the upland valleys of the "Indian Caucasus" are regarded, if not as the cradle, at least as the centre of dispersion of the Aryan branch of the Caucasic group. Hence, those members of the Aryan family still occupying both slopes of the Hindu-Kush are supposed to be found, so to say, *in situ*, that is, in undisturbed possession of their primeval homes from the first. Such are, on the south side, the so-called SIAH-POSH, or SIAH-POSH KAFIRS ("Black-clad Infidels"), and further

east the numerous communities often collectively known as DARDS; on the north side the BADAKHSHI, WAKHI, and SHUGNÁNI, to whom, with the other kindred highlanders of Roshán, Darwáz, and Karateghin, beyond the Oxus, Ch. de Ujfalvy has applied the collective term GALCHA. That all are fundamentally of one stock there can be no doubt, although much uncertainty prevails regarding their position in the Aryan family.

The northern group (Badakhshi, Wakhi, Shugnáni) have long been brought within the sphere of Iranian culture. Some are Parsiván, that is, Parsi-zabán, or "Persian-tongued"; others, especially in Wakhan, still retain much of their primitive speech, which appears to be intermediate between the Indic and Iranic members of the Aryan family. But all are at least nominal Mohammedans of the Sunni sect, and recognise the supremacy of the Amir of Kábul. In view of future political intrigue on this extreme north-east frontier, it will be desirable to bear in mind the close affinity and common sympathies of all these communities on both sides of the Upper Oxus.

Even more interesting, and in some respects more important, is the southern group of Siah-Posh Kafirs, who occupy the upland valleys between Kohistán and the Swati district, and even visit the northern pastures west of the Dora Pass, crossing the Hindu-Kush at an altitude of some 16,000 feet. In these mountain fastnesses they have hitherto succeeded in preserving intact not only their primitive speech, usages, and religion, but even their political independence. Although included within the limits of the Amir's possessions, no Afghan ventures to penetrate into their territory, which till quite recently was almost a *terra incognita*. By Major Tanner, and the few other Europeans by whom they have been visited, they are described as of a pure Caucasic type, with regular features, blue and dark eyes, hair varying from brown to black, and altogether the most European in appearance of all Asiatic peoples. With the British rulers of India they claim kindred, trace their descent from Alexander the Great, differ from other Asiatics in the use of chairs and tables, and speak a pure Aryan dialect, showing marked affinities to Sanskrit. Some few in the extreme south and west have become assimilated in speech and religion to their Afghan neighbours, and these Safi and Nemchi, as they are called, serve as the medium of communication between the two races. For obvious reasons the masters of India should cultivate the friendship and alliance of the Siah-Posh highlanders, who, from the name of their most powerful *gali*, or tribe, sometimes take the collective name of Kamoji.

The south-western slopes of the Hindu-Kush north of Kábul are held by several little known tribes vaguely known as KOHISTÁNI, or "Hill men." They occupy the whole district between Kafiristán and the Koh-i-Baba. They are mainly Tajiks, that is, Iranians, probably descended of Persian settlers in pre-Mohammedan times, and still speak a rude Persian dialect. Although now Mohammedans of the Sunni sect, they appear to be an unruly people, owing a reluctant allegiance to the Amir, in this and some other respects differing from the other Tajiks found dispersed in settled communities elsewhere in Afghanistan and throughout the whole of Central Asia. The name, referred to the root *táj* = *crown*, is supposed to mean "crowned," indicating the imperial race that once held sway from the Bosporus to the Indus. But the sceptre has long passed from Irán to Turán even in Persia itself, where the reigning dynasty belongs to the Qajár tribe, of Turkoman stock.

As already stated, both slopes of the North Afghan highlands are in almost exclusive possession of Mongolic peoples from the Koh-i-Baba to Herat, east and west, and from Afghan Turkestan southwards to the Ghor uplands. Here both branches of the Mongolo-Tatar group are represented, the Mongols proper by the HAZARAHS and the AIMAKS, the Tatars by the TURKOMANS and the KATAGHÁNI USBEGS. With the Hazarahs are sometimes grouped the JEMSHÍDIS and FIRUZ-KHOI of the province of Herat. But both of these numerous communities appear to be fundamentally of Iranian stock, although the type has to some extent been modified by contact with the surrounding Mongolo-Tatar tribes.

Thus it appears that, as above remarked, the Afghans proper nowhere occupy any territory along their northern frontier, but, except at Herat, have everywhere been driven into the interior of the plateau by the intruding Central Asiatic races. It is further to be noted that although they hold the Usbegs of the Tirband-i-Turkestán escarpment and of the Turkestán lowlands in military subjection, they have hitherto failed to reduce either the Aimaks of the Ghor district or the Hazarahs of the Koh-i-Baba and Safed-Koh ranges. The direct route from Herat to Kábul through this region has not only never yet been traversed by any European explorer, but is absolutely inaccessible to the Afghans themselves. Hence it is that the military and trade route between these two points is deflected a long way southwards to the Helmand basin and to Kandahar, whence it laboriously creeps up through the Ghazni highlands to the Kábul valley.[1] Hence also the vast strategic importance of such places as Kandahar and Girishk on the Helmand, which depends, not, as is generally supposed, so much on the lie of the land, as on the ethnical conditions of its inhabitants. The future masters of the Aimak and Hazarah tribes will not only secure the rich prize of the Ghor region, with its untouched mines of gold, silver, copper, lead, iron, coal, sulphur, rubies, and emeralds, but will also command the direct and natural route from Herat to the Indus, *viâ* Kábul and Pesháwar.

Meantime, these Aimaks and Hazarahs, neglected by our statesmen, continue to interest our men of science alone. Their flat features, tawny complexion, scant beard, oblique eyes, and prominent zygomatic arches, betray their common Mongolic descent, while the somewhat rude Persian dialect generally spoken by both implies long contact in their new homes with Iranian culture. Both are also Mohammedans; the Aimaks of the Sunni, the Hazarahs of the Shiah sect, in this respect differing from all other Mongolian tribes, who are exclusively Buddhists. Another proof of Persian influence is the settled life of the Hazarahs,[2] who have long ceased to be nomads, and now occupy permanent villages of small thatched houses. Of late years they have begun to migrate towards India, where they find employment on the public works.

The Aimaks, or Char Aimaks, that is "Four Hordes," so named from their four main divisions, occupy, besides the Ghor country, extensive tracts on the northern slope of the border ranges, on the hills encircling Herat, and beyond the frontier in Khorasán. Some communities in the Herat district have preserved their mother-tongue, and their chief tribe even still bears the Mongol name of Kipchak. They also retain the old *urdu*, or tents made of felt or skins, and usually grouped round a central tower or stronghold occupied by the chief. They are described as altogether more savage and ferocious than their Hazarah neighbours, and are even said to drink the blood of the slain in battle (Elphinstone).

With the fall of Merv all the hitherto independent Turkoman tribes passed under the sceptre of the "White Czar," except the SARIKS and the SALORS. Soon after that event the Sariks of the Merv oasis gave in their submission to the number of about 10,000 families. When that district was invaded in 1860 by the Tekkés, the Salors, its original masters, withdrew higher up the Murgháb valley, where they are still found within and about the Afghan frontier, on the route between Merv and

[1] The direct route is little over 360 miles, the detour by Kandahar about 550.

[2] Probably so named from the Persian *hazár* = a thousand, in allusion to their numerous tribal subdivisions.

Herat. They do not recognise the authority of the Amir of Kábul, and should the Czar, who is about to assume the title of "Emperor of Central Asia," claim the allegiance of this outlying Central Asiatic tribe, here will be a fruitful source of future complications. Their submission would at once advance the Russian frontier far into Afghan territory and up the Murgháb valley to within easy distance of Herat from the north. The route in this direction is well known, and constantly traversed by traders from Khiva, Bokhara, and Samarkand. It appears to present no greater difficulties than the more westerly route crossing the Barkhut ridge recently surveyed by Lessar.

There remain to be mentioned the KATAGHÁNI USBEGS, who form the bulk of the population in Afghan Turkestán. They belong to the same ethnical group as the Usbegs of the Khanates, and have even some settlements in Bokhara beyond the Oxus. They are mostly agriculturists and traders, Sunnite Mohammedans of pure Turki speech, and bear with reluctance the hard yoke of their Afghan masters. Their sympathies are entirely with their northern kinsmen, and as the country (Kunduz, Balkh, Maimene) belongs geographically to the Aralo-Caspian basin, it is difficult to see how further rectifications of frontier can ultimately be prevented in this direction. Exponents of advanced public opinion in Russia already openly claim the whole of this region to the crest of the Hindu-Kush as properly belonging to the ruler of Central Asia, and their arguments are largely based on ethnological grounds.

Table of the North Afghan Border Tribes

CAUCASIC STOCK

	Tribe	*Locality*	*Population* [1]
Galchas	Siah-Posh	Kafiristán	150,000
	Badakhshi	Badakhshán	160,000
	Wakhi	Wakhán	3,000
	Shugnáni	Shugnán	25,000
Iranians	Kohistáni	Kohistán	?
	Firuz-Khoi... ...	Prov. Herat, Murgháb Valley	30,000 tents
	Jemshidi	Prov. Herat, Khushk Valley	12,000 families
	Tajiks...	Herat, Balkh, &c.	200,000 ?
	Afghans	Herat	100,000 ?

MONGOLIC STOCK

	Tribe	*Locality*	*Population*
Mongols	Hazarahs	Hazaraját ... ... Koh-i-Baba, Safed-Koh ...	300,000
	Aimaks	Ghor, Herat, Khorasán ...	350,000
Tatars	Salor Turkomans	About Martshag, Murgháb Valley	30,000
	Katagháni Usbegs	Afghan Turkestán, Bokhara	600,000

A. H. KEANE

[1] Population mostly conjectural.

ANTHROPOMETRIC PER-CENTILES

I SEND the following Table, partly to exemplify what I trust will be found a convenient development of a statistical method that I have long advocated, and partly for its intrinsic value, whatever that may be. It will at all events interest those of the 9337 persons measured in my Anthropometric Laboratory at the late International Health Exhibition, who may wish to discover their rank among the rest.

Its meaning is plain, and will be understood by the help of a single example, for which I will take the line referring to Strength of Squeeze among males. We see that a discussion was made of 519 measurements in that respect, of men whose ages ranged between 23 and 26; that 95 per cent. of them were able to exert a squeeze with their strongest hand (the squeeze was measured by a spring dynamometer) that surpassed 67 lbs. of pressure; that 90 per cent. could exert one that surpassed 71; 80 per cent. one that surpassed 76; and so on. The value which 50 per cent. exceeded, and 50 per cent. fell short of, is the Median Value, or the 50th per-centile, and this is practically the same as the Mean Value; its amount is 85 lbs. This line of the Table consequently presents an exact and very complete account of the distribution of strength in one respect among the middle 90 per cent. of any group of males of the tabular ages similar to those who were measured at the laboratory. The 5 per cent. lowest and the 5 per cent. highest cannot be derived directly from it, but their values may be approximately inferred from the run of the tabular figures, supplemented by such deductions as the Law of Error may encourage us to draw. Those who wish to apply this law will note that the probable error is half the difference between the 25th and the 75th per-centile, which can easily be found by interpolation, and they will draw the per-centiles that correspond respectively to the median value *minus* twice, three times, and three-and-a-half times the probable error, at the graduations 8·7, 2·4, 0·8, and those that correspond to the median value *plus* those amounts, at the graduations 91·3, 97·6, and 99·2. The Table is a mere statement of observed fact; there is no theory whatever involved in its construction, beyond simple interpolations between values that differ little from one another and which have been found to run in very regular series.

It may be used in many ways. Suppose, for example, that a man of the tabular age, viz. above 23 and under 26, and who could exert a squeeze of 80 lbs., desired to know his rank among the rest, the Table tells him at once that his strength in this respect certainly exceeds that of 30 per cent. of those who were measured, because if it had been only 79 lbs. it would have done so. It also tells him that his strength does not exceed that of 40 per cent. of the rest, since it would have required a pressure of 82 lbs. to have done this. He therefore ranks between the 30th and the 40th per-centile, and a very simple mental sum in proportion shows his place to be about the 33rd or 34th in a class of 100.

The Table exhibits in a very striking way the differences between the two sexes. The 5th male per-centile of strength of squeeze is equal to the 90th female per-centile, which is nearly but not quite the same as saying that the man who ranks 5th from the bottom of a class of 100 males would rank 10th from the top in a class of 100 females. The small difference between the two forms of expression will be explained further on. If the male per-centiles of strength of squeeze are plotted on ruled paper, beginning with the lowest, and if the female per-centiles are plotted on the same paper, beginning with the highest, the curves joining their respective tops will be found to intersect at the 7th per-centile, which is the value that 7 of the females and 93 of the males just surpass. Therefore, if we wished to select the 100 strongest individuals out of two groups, one consisting of 100 males chosen at random, and the other of 100 females, we should take the 100 males and draft out the 7 weakest of them, and draft in the 7 strongest females. Very powerful women exist, but happily perhaps for the repose of the other sex, such gifted women are rare. Out of 1657 adult females of various ages measured at the laboratory, the strongest could only exert a squeeze of 86 lbs. or about that of a medium man. The population of England hardly contains enough material to form even a few regiments of efficient Amazons.

The various measurements of males surpass those of females in very different degrees, but in nearly every particular. A convenient way of comparing them in each case is that which I have just adopted, of finding the per-centile which has the same value when reckoned from the lower end of the male series, and from the higher end of the female series. When this has been done, the position of the

ANTHROPOMETRIC PER-CENTILES

Values surpassed, and Values unreached, by various percentages of the persons measured at the Anthropometric Laboratory in the late International Health Exhibition

(*The value that is unreached by n per cent. of any large group of measurements, and surpassed by* 100–*n of them, is called its nth per-centile*)

Subject of measurement	Age	Unit of measurement	Sex	No. of persons in the group	Values surpassed by per-cents as below: 95	90	80	70	60	50	40	30	20	10	5
					Values unreached by per-cents. as below: 5	10	20	30	40	50	60	70	80	90	95
Height, standing, without shoes ..	23-51	Inches	M.	811	63·2	64·5	65·8	66·5	67·3	67·9	68·5	69·2	70·0	71·3	72·4
			F.	770	58·8	59·9	61·3	62·1	62·7	63·3	63·9	64·6	65·3	66·4	67·3
Height, sitting, from seat of chair ...	23-51	Inches	M.	1013	33·6	34·2	34·9	35·3	35·4	36·0	36·3	36·7	37·1	37·7	38·2
			F.	775	31·8	32·3	32·9	33·3	33·6	33·9	34·2	34·6	34·9	35·6	36·0
Span of arms ...	23-51	Inches	M.	811	65·0	66·1	67·2	68·2	69·0	69·9	70·6	71·4	72·3	73·6	74·8
			F.	770	58·6	59·5	60·7	61·7	62·4	63·0	63·7	64·5	65·4	66·7	68·0
Weight in ordinary indoor clothes ..	23-26	Pounds	M.	520	121	125	131	135	139	143	147	150	156	165	172
			F.	276	102	105	110	114	118	122	129	132	136	142	149
Breathing capacity	23-26	Cubic inches	M.	212	161	177	187	199	211	219	226	236	248	277	290
			F.	277	92	102	115	124	131	138	144	151	164	177	186
Strength of pull as archer with bow	23-26	Pounds	M.	519	56	60	64	68	71	74	77	88	82	89	96
			F.	276	30	32	34	36	38	40	42	44	47	51	54
Strength of squeeze with strongest hand	23-26	Pounds	M.	519	67	71	76	79	82	85	88	91	95	100	104
			F.	276	36	39	43	47	49	52	55	58	62	67	72
Swiftness of blow.	23-26	Feet per second	M.	516	13·2	14·1	15·2	16·2	17·3	18·1	19·1	20·0	20·9	22·3	23·6
			F.	271	9·2	10·1	11·3	12·1	12·8	13·4	14·0	14·5	15·1	16·3	16·9
Sight, keenness of—by distance of reading diamond test-type	23-26	Inches	M.	398	13	17	20	22	23	25	26	28	30	32	34
			F.	433	10	12	16	19	22	24	26	27	29	31	32

per-centiles arranged in order of their magnitude are as follows:—Pull, 4; Squeeze, 7; Breathing capacity, 10; Height, 14; Weight, 26; Swiftness of blow, 26; Keenness of sight, 37. We conclude from them that the female differs from the male more conspicuously in strength than in any other particular, and therefore that the commonly used epithet of "the weaker sex," is peculiarly appropriate.

The Table was constructed as follows:—I had groups of appropriate cases extracted for me from the duplicate records by Mr. J. Henry Young, of the General Register Office. I did not care to exhaust the records, but requested him to take as many as seemed in each case to be sufficient to give a trustworthy result for these and other purposes to which I desired to apply them. The precise number was determined by accidental matters of detail that in no way implied a selection of the measurements. The summarised form in which I finally took them in hand, is shown in the two upper lines of the following specimen:—

Height, Sitting, of Female Adults, Aged 23–50, *in inches*

29–	30–	31–	32–	33–	34–	35–	36–	37–	
2	8	52	116	226	227	108	31	5	Total 775
2	10	62	178	404	631	739	770	775	Abscissæ 0 to 775
30	31	32	33	34	35	36	37	38	Corresponding Ordinates

The meaning of the two upper lines is that in a total of 775 observations there were 2 cases measuring 29 and under 30 inches, 8 cases measuring 30 and under 31 inches, and so on. The third line contains the sums of the entries in the second line reckoned from the beginning, and is to be read as follows:—2 cases under 30 inches, 10 cases (= 2 + 8) under 31 inches, 62 cases (= 2 + 8 + 52) under 32 inches, and so on.

I plotted these 775 cases on French "sectional" paper, which is procurable in long and inexpensive rolls, ruled crossways by lines 1 millimetre apart. I counted the first line as 0° and the 776th as 775°. Supposing the measurements to have been plotted in the order of their magnitude, in succession between these lines, the first would stand between 0° and 1°, the second between 1° and 2°, and so on. Now we see from the Table that the second measurement was just short of 30 inches, consequently the third measurement was presumably just beyond it, therefore the abscissa whose value is 2°, and which separates the second from the third measurement, may fairly be taken to represent the abscissa of the ordinate that is equal to 30 inches exactly. Similarly, the abscissa whose value is 10° divides the measurement that is just under 31 inches from that which is presumably just above it, and may be taken as the abscissa to that ordinate whose precise value is 31°, and so on for the rest. The fourth line of the Table gives the ordinates thus determined for the abscissæ whose values are entered above them in the third line. I dotted the values of these ordinates in their right places on the sectional paper, and joined the dots with a line, which in every case, except the breathing capacity, fell into a strikingly regular curve. (I cannot account for this one partial exception, save on the supposition of the somewhat irre-

gular mixture of town and country folk, and of sedentary and active professions among the persons measured, but I have not yet verified this surmise.) Per-centiles were then drawn to the curve corresponding to abscissæ that were respectively 5 per cent., 10 per cent., 20 per cent., &c., of the length of the base line. As the length of the base-line was 275, these per-centiles stood at the graduations $13^{\circ}\cdot 8$, $27^{\circ}\cdot 5$, $55^{\circ}\cdot 0$, &c. Their values, as read off on the sectional paper, are those which I have given in the Table.

It will be understood after a little reflection that the 9th rank in a row of 10, the 90th rank in a row of 100, and the 900th rank in a row of 1000, are not identical, and that none of them are identical with the 90th percentile. There must always be the difference of one half-place between the post which each person occupies in a row of n individuals, numbered from 1 to n, and that of the corresponding graduations of the base on which they stand, and which bear the same nominal value, because the graduations are numbered from 0 to n and begin at a point one half-place short of the first man, and end at one half-place beyond the last man. Consequently the graduations corresponding to the posts of the 9th, 90th, and 900th man in the above example, refer to the distance of those posts from the beginning at 0 of their several base lines, and those distances are related to the lengths of the base lines in the proportions of 8·5 : 10, 89·5 : 100, and 899·5 : 1000, which when reckoned in per-cents of the several base lines are 85, 89·5, and 89·95 respectively. The larger the number of places in the series, the more insignificant does this half-place become. Moreover, the intrusion of each fresh observation into the series separates its neighbours by almost double that amount, and propagates a disturbance that reaches to either end, though it is diminished to almost nothing by the time it has arrived there. We may therefore ignore the existence of this theoretically troublesome half-place in our ordinary statistical work.

There is a latent source of error that might affect such statistics as these, as well as many others that are drawn up in the usual way, which has not, so far as I know, been recognised, and deserves attention. It is due to uncertainty as to the precise meaning of such headings as 30-, 31-, &c. If the measurements, no matter whether they were made carefully or carelessly, are read off from the instruments with great nicety, then a reading such as 30·99 would fall in the column 30-, and the mean of all the entries in such a column might fairly be referred to a mean value of 30·5.

But if the instruments are roughly read, say, to the nearest half inch, the reading of a real instrumental value of 30·99, and even that of a real value of 30·76, would both be entered in the column 31-. The column 30- would then contain measurements whose real instrumental values ranged between 29·75 and 30·75, and the column 31- would contain those that ranged between 30·75 and 31·75; consequently, the means of all the entries in those columns respectively should be referred, not to 30·5 and 31·5, but to 30·25 and to 31·25. An error of a quarter of an inch in the final results might easily be occasioned by the neglect to note the degree of minuteness with which the instruments were read, and I strongly suspect that many statistical tables are affected by this generally unrecognised cause of error. The measurements at my laboratory were read to the nearest tenth of an inch and to a fraction of a pound, so I can afford to disregard this consideration. There was, however, a slight bias in favour of entering round numbers, which should have been, but were not (because I neglected to give the necessary instructions), rateably divided between the columns on either side.

A fuller description of the results of the measurements at the laboratory will appear next February or March in the forthcoming number of the *Journal* of the Anthropological Institute, at which place the original data will ultimately be deposited.

FRANCIS GALTON

NOTES

IT having become known to some of the friends of the late Mr. Henry Watts, the well-known chemist, whose death occurred very suddenly on the 30th of last June, that his widow and family are in very straitened circumstances, an informal meeting was recently held at the Royal Institution. Those present resolved to form themselves into a committee, with power to add to their number, in order to collect a fund for the benefit of Mrs. Watts and those of her children who are not of an age to provide for their own support. Dr. Atkinson consented to act as secretary, and Dr. Perkin, President of the Chemical Society, as treasurer. Among the names on the committee are those of Sir F. A. Abel, Prof. H. E. Armstrong, Mr. William Crookes, Dr. Warren De La Rue, Prof. James Dewar, Prof. G. C. Foster, Dr. J. H. Gladstone, Prof. A. G. V. Harcourt, Dr. Hugo Müller, Dr. William Odling, Dr. W. H. Perkin, Dr. B. W. Richardson, Prof. W. Chandler Roberts, Sir H. E. Roscoe, Dr. W. J. Russell and Prof. A. W. Williamson. Mr. Watts's public labours for the advancement of chemical science may be said to have begun with the translation of Gmelin's "Handbook of Chemistry," the admirable English edition of which was prepared and edited for the Cavendish Society by him. This work occupies eighteen large octavo volumes, of which the first appeared in 1849, and the last in 1871. A work scarcely, if at all, inferior to this in magnitude, and one which has perhaps been of even greater service to English chemists, both scientific and industrial, is Watts's great "Dictionary of Chemistry," which appeared from 1863 to 1881, in eight volumes, containing altogether nearly 9700 pages. Mr. Watts also edited and largely added to the second volume of the late Prof. Graham's "Elements of Chemistry," published in 1858; he prepared several editions of Fownes's well-known "Manual of Chemistry," which he almost entirely re-wrote and made into virtually a new work; and in conjunction with Mr. Ronalds and Dr. Richardson, he prepared for Messrs. Baillière an elaborate treatise on chemical technology. Up to the time of his death, and for about thirty years previously, Mr. Watts was editor of the *Journal* of the Chemical Society, and in this capacity, as well as in that of librarian to the Chemical Society, he became personally known to and gained the friendship of very many among the Fellows of the Society. But although Mr. Watts's life was one of unremitting labour, the money return for his work was barely sufficient to enable him to provide for the daily wants of a delicate wife and a numerous family. It was not possible for him to provide for their future needs. But if he could not leave behind him pecuniary resources, he accumulated esteem and affection among all who knew him, which, it is confidently hoped, will prove a valuable legacy for those who were dependent on him. The facts of the case show that there is great need of whatever practical proof of their regard for him and appreciation of his labours Mr. Watts's friends, and English chemists generally, may be willing to make. For many years Mrs. Watts has been in ill-health, so that she cannot do anything for her own support and that of her family. One son is a permanent invalid, and the four youngest children have still to be educated. A considerable expenditure is therefore unavoidable for a good many years to come, if the children are to have a fair chance of a start in life. A considerable sum has already been promised in the way of subscriptions, but much more will have to be done in order that any substantial benefit may accrue to Mrs. Watts and her young family. Subscriptions will be received and acknowledged

by the Secretary, Dr. Edmund Atkinson, Portesbery Hill, Camberley, Surrey, or by the Treasurer, Dr. W. H. Perkin, the Chestnuts, Sudbury, Harrow.

M. MILNE EDWARDS has been nominated by the French Government Grand Officer of the Legion d'Honneur.

LECTURES in connection with the London Society for the Extension of University Teaching have been going on in Whitechapel now for more than six years. The number of tickets sold for the lectures during this period has been close upon 2000, and the ticket-holders have been nearly all artisans. The reports of the examiners, appointed by the Universities' Board, have shown that many of those attending the lectures are real students—a conclusion which is also borne out by the fact that the same subjects have been studied for several years in succession. It has been felt that a good reference library and reading room would be a great help to the existing students, as well as a means of attracting others. An opportunity for providing these advantages is now afforded in the "Universities' Settlement" in Toynbee Hall, where the lectures will in future be given, and a reading room be opened to the students. The Committee desire to stock this room with a good reference library—especially in the subjects of history, political economy, physics, and physiology—and will be very grateful for any assistance in this attempt to further higher education among working men and women in East London. Any one willing to help, either with books or with money, is requested to communicate either with E. T. Cook, 22, Albemarle Street, W. (Sec. London Society for the Extension of University Teaching), or Bolton King, 28, Commercial Street, E. (Hon. Sec. Whitechapel Local Committee).

THE mean-time clocks at the Royal Observatory, Greenwich, were put forward twelve hours a little before midnight of December 31, in order that the commencement of the civil day and the astronomical day might be identical from January 1, 1885. The public clock near the entrance to the Observatory will thus indicate the hours as recommended by the Washington Conference—*i.e.* reckoning from 0h. to 24h., starting from midnight. As the Greenwich observations for 1885 will not be printed until 1886, the proposed method can be tried for a year before the necessity of deciding on its adoption will arise. In writing to the Rev. T. E. Espin, President of the Liverpool Astronomical Society, the Astronomer-Royal says:—"The change that we propose to make at Greenwich is for the present provisional only, as it appears essential that it should be generally accepted by astronomers before it is introduced into any published observations I am very anxious to avoid the confusion which would result from two systems of reckoning time being in use among astronomers. But as regards the ordinary public, it seems to me clear that for civil reckoning the day must commence at midnight, and in order to assist in familiarising the public with the reckoning from 0h. to 24h., I propose on January 1 to alter our public clock (which is numbered from 0h. to 24h.) by 12h., so that it will show civil reckoning instead of the old astronomical reckoning."

CHEMISTS will regret to learn that Dr. Edward Divers, Principal of the Imperial College of Engineering, Tokio, Japan, has met with a very serious accident, which it is feared will result in the loss of one of his eyes. He is understood to have been engaged in work in connection with the theory of acids, when a bottle, supposed to contain terchloride of phosphorus, exploded, causing him very severe injuries. Dr. Divers is well known as the author of many valuable chemical papers read before the Royal and other scientific societies.

MR. ALFRED TYLOR, F.G.S., who died on December 31 last, will be remembered as a promoter of technical education at a time when its vital importance was little recognised, and the English manufacturing mind was generally set against it. He was intimately associated with Dr. von Steinbeis, whose energy in this direction did so much to give the little kingdom of Wurtemburg its industrial prominence in Germany. Mr. Tylor's work, "Education and Manufactures," arising out of his Jury Report on Metal Work at the Exhibition of 1862, was translated into German under the title "Industrie und Schule" (Stuttgart, 1865), and also appeared in Swedish. Mr. Tylor sat for some years on the Council of the Geological Society. His geological papers relate principally to the flow of rivers as connected with the erosion of valleys and the deposit of gravel-beds; they contain much systematised information, for instance, as to the mechanical action of the Mississippi and the Ganges. It is well known that his study of river-valleys and drift-gravels led him to the hypothesis of a post-glacial time of enormous rainfall, which he called the "pluvial period." The term, though not generally accepted, is found of use, to judge from its not unfrequent appearance in geological works.

THE death is announced, at the age of seventy-four years, of Dr. Andrew Findlater, for so many years connected with the editorial department of Messrs. W. and R. Chambers. Dr. Findlater wrote several of the scientific volumes in Chambers's well-known "Educational Course," and edited a revised edition of the "Information for the People." But his most important undertaking was the editing of "Chambers's Encyclopædia," the scientific articles in which hold so high a place, mainly through Dr. Findlater's knowledge, discernment, and tact in obtaining the right men to act as contributors. Dr. Findlater was offered the editorship of the new edition of the "Encylopædia Britannica," but was induced to decline it.

WE read in the German papers that the Greek Government has offered to supply the marble, as it did in the case of Lord Byron's monument in England, for a national monument to be erected to Wilhelm Müller, the father of Prof. Max Müller, in his native town of Dessau. Wilhelm Müller is best known as the poet of the "Müller-lieder," beautifully set to music by Schubert. But the Greek Government, in the name of the Greek nation, wished to express its recognition of the great services rendered to the cause of Greek independence by Wilhelm Müller, "the Philhellenic Tyrtæus," whose "Griechenlieder" belong to the classical literature of Germany. Committees have been formed in Germany, Italy, Greece, and America. The English committee consists of Mrs. Jenny Lind-Goldschmidt, Sir Theodore Martin, Sir Robert Morier, Sir George Grove, J. A. Froude, and Prof. Buchheim. Subscriptions are received by Messrs. Williams and Norgate, 14, Henrietta Street, W.C.

BAVARIAN papers report the death, after a short illness, of Dr. Philip von Jolly, Professor of Mathematical and Experimental Physics in the University of Munich, in the seventy-fifth year of his age.

A NEW association has been established among the students of the University of Paris. The first step of this institution has been the organisation of a public manifestation in honour of M. Chevreul, the director of the Museum, who is just completing his 100th year. He is the first French academician who has reached this advanced age since the death of Fontenelle, who died about 1750, a few days before completing his century. A little before his death Fontenelle was heard to say to one of his friends asking if he complained of some illness, "I have no suffering, but I am feeling merely an increased difficulty of living."

WE learn from *Science* that the "cold-wave flag," whose use has been inaugurated by the U.S. Signal Service during the past autumn, is intended to be displayed not only at the regular

stations of the Signal Service, but also at as many railway-stations and post-offices as possible, in order to spread the widest notice of the coming change of weather. The service cannot at present undertake to provide the flags or to pay for special telegrams to numerous local display-stations; but the cost of the flags (white, six feet square, with a two-foot black square in centre) is moderate, and can easily be borne by those interested in securing early indications of falling temperature; and in several parts of the country the telegrams are sent to all the stations on certain railroads that co-operate with the Signal Service, and thus promptly distribute weather forecasts to the towns along their routes. It is probable that the coming year will see a considerable extension of this kind of weather service.

M. Jamin, the Perpetual Secretary of the Paris Academy of Sciences, has published, in the January issue of *Revue des Deux Mondes*, the essay on balloons, which we announced a few weeks ago. The academician takes a very moderate view of the success of the Meudon and Point du Jour experiments.

The terrestrial disturbance in Southern Spain, which began with violent earthquake shocks on Christmas night, still continues, and other earthquakes are reported from Austria and Italy. From Vienna information comes of repeated shocks on the 4th inst. in the hot-spring district of Southern Styria, during which some slight damage was done, while on the afternoon of the same day a shock, perhaps of the same earthquake, was felt at Susa, near Mont Cenis, and one of greater force on the morning of the following day (January 5) at Velletri, near Rome. The seismic instruments at the observatory in Rome and at Rocca di Papa showed unusual activity on the 5th and previous days, especially at midday, and at night the mineral springs in the Island of Ischia have risen in temperature. It would thus appear that the present is a period of unusual seismic disturbance throughout Southern Europe. In Spain no day has passed since the 25th ult. without one or more severe shocks in the disturbed area. On the 31st ult. the tenth violent shock in a week occurred in Granada—the people left their houses for the night—and up to that date 10,000 people had left the town altogether. On the same day and on the 1st inst. shocks continued at Jaen, Torrox, Malaga, Benamargoza, and Velez Malaga. At Torrox buildings were thrown down, and the town has been wholly abandoned. At Nerja the church was damaged, and at Arenas del Rey 500 persons were either killed or injured. On the 1st inst. and the morning of the 2nd fresh shocks were felt at Nerja, Algarrobo, Granada, and Malaga. A number of towns and villages are reported completely destroyed and deserted. On the 2nd shocks were felt along the Mediterranean coast of Granada and Malaga. Up to noon on the 3rd inst., according to official statistics, 673 bodies were recovered from the ruins of towns in the province of Granada alone. On that day the shocks were renewed in Loja, Alhama, Jaen, and Velez Malaga, fissures being made in the ground. The town of Alhama, which has suffered most severely of all, is composed of two parts, the upper and lower. During the earthquake on Christmas night the upper town, situated on the side of a valley, fell into the lower portion. Over 1500 houses were destroyed, and more than 300 dead were recovered up to the 4th inst. It is calculated that 10,000 head of cattle were killed. Besides this, five churches, five convents and hospitals, the town-hall, the prisons, clubs, and theatre were destroyed, and 7000 people rendered homeless. On the 5th a sharp shock occurred at Granada a few minutes after 6 in the evening, and some slight shocks were felt at Malaga.

At the Royal Institution, Prof. H. N. Moseley will, on Tuesday next (January 13), begin a course of five lectures on "Colonial Animals, their Structure and Life Histories"; Prof. Dewar will, on Thursday (January 15), begin a course of eleven lectures on "The New Chemistry"; and Dr. Waldstein will, on Saturday (January 17), begin a course of three lectures on "Greek Sculpture from Pheidias to the Roman Era." The Friday evening meetings will begin on January 16, when Prof. Tyndall will give a discourse on "Living Contagia."

According to the *North China Herald* there died a few months ago at Pekin, the greatest Chinese mathematician of the present century. His name was Li Shan-lan, and he was Professor of Mathematics at the Foreign College in the Chinese Capital. He differed from the mathematicians of Europe in this respect, that he denied the non-existence of a point. "A point," said Prof. Li, "is an infinitesimally small cube," and in saying this he only reproduced the theories of Chinese sophists 2000 years ago. A great writer of that age put into the mouth of a sophistical being, whom he called the god of the northern sea, the following theory, which has its bearing on Prof. Li's heterodox views about a mathematical point: Subtlety is the occult part of the minute. Be a thing subtle or gross, it seems to me that it must have a form. A formless or unsubstantial thing cannot be distinguished as gross or subtle, discriminate as minutely as you will. What can be spoken of is the gross or palpable part of an entity; what can be imagined only is its subtle part or essence; but I take it that what is neither gross nor subtle can neither be talked of nor imagined.

M. Lauth, the superintendent of the porcelain factory at Sèvres, is said to have discovered a new porcelain, which is far superior to the famous old Sèvres. After ten years' experiment and investigation he thinks he has produced a porcelain identical with that of China. Not only does it lend itself to artistic decoration, but it takes all kinds of glazes, and surpasses in beauty the colours obtained in China.

A proposition to connect Sicily with the mainland, by a submarine railway from Messina to Reggio, has been made by the Society of Engineering of Venice. It has been laid before the Minister of Public Works, who has referred it to a technical commission. A project by the French engineer who constructed the first railways in Rome to build a suspension bridge across the Straits of Messina, was laid at the time before Francis II.; but Garibaldi's campaign in Sicily, and the subsequent political events, caused it to be put aside.

We learn from an Adelaide paper of November 3, 1884, that Mr. Clement L. Wragge has now extended his plan of operations on Mount Lofty, and has established, as a further experiment, a substantially equipped meteorological observatory there. At the Torrens Observatory readings are taken in direct connection with the observations on the Mount, 2350 feet.

Prof. Sylvester asks us to state that in his article "On the Genesis of an Idea," the footnote on p. 36, left-hand column, should read:—"It is one of Descartes' 'self-evident primary truths' that nothing which has happened could not have happened or have happened otherwise." The words "have happened" unfortunately dropped out.

The additions to the Zoological Society's Gardens during the past week include a Vervet Monkey (*Cercopithecus lalandii* ♂) from South Africa, presented by Mr. J. W. Moon; a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Mrs. M. E. Mackern; a Brown Hyæna (*Hyæna brunnea*) from South Africa, presented by Mr. R. W. Murray; a Nubian Ibex (*Capra nubiana* ♂), a —— Ibex (*Capra* —— ♂), a Domestic Goat (*Capra hircus* ♀) from the Soudan, presented by Mrs. Laing; seven Angulated Tortoises (*Chersina angulata*), two Hoary Snakes (*Coronella cana*), a Many-spotted Snake (*Coronella multimaculata*), a Robben Island Snake (*Coronella phocarum*) from South Africa, presented by the Rev. G. H. R. Fisk, C.M.Z.S.; a Golden Eagle (*Aquila chrysaetos*), European, deposited; a —— Gibbon (*Hylobates* ——) from Siam, purchased.

OUR ASTRONOMICAL COLUMN

THE TOTAL SOLAR ECLIPSE OF 1914, AUGUST 20–21.—There have been given in this column, at various times, particulars of the track of the central line in a number of the total eclipses of the sun that will occur during the next thirty years. To these may be added similar notes on the eclipse of August 20–21, 1914, which is a return of that of July 29, 1878, so extensively observed in the United States. The elements of this eclipse are very approximately as follow:—

G.M.T. of Conjunction in R.A. 1914, August 20, 23h. 55m. 3s.

	°	′	″	
R.A.	149	45	36·1	
Moon's hourly motion in R.A. ...		33	7·5	
Sun's ,, ,, ...		2	18·9	
Moon's declination	13	9	42·2	N.
Sun's ,, ...	12	19	29·1	N.
Moon's hourly motion in declination		15	16·0	S.
Sun's ,, ,, ,, ...			49·7	S.
Moon's horizontal parallax		59	17·6	
Sun's ,, ,, ...			8·7	
Moon's geocentric semi-diameter ...		16	11·0	
Sun's ,, ,, ,, ...		15	51·1	

Hence it will be found that the

	°	′			°	′	
Total eclipse begins in long.	120	42	W.,	lat.	71	21	N.
,, ,, at 0h. ,,	2	0	E.	,,	70	42	N.
,, ,, ends ,,	70	26	E.	,,	23	52	N.

In traversing the European continent, the central line runs through the points

Long.	Lat.	Long.	Lat.
12° 33′ E. ...	65° 48′ N.	30° 33′ E. ...	50° 35′ N.
14 39 ,, ...	64 32 ,,	32 53 ,, ...	48 2 ,,
22 44 ,, ...	58 23 ,,	39 12 ,, ...	41 23 ,,
27 30 ,, ...	53 48 ,,	46 28 ,, ...	34 52 ,,

The first of these points is close upon the coast of Norway, at the Island of Alstahoug, and on making a direct calculation for it, the totality is found to commence at 0h. 54m. 19s. local mean time, continuing 1m. 59s., with the sun at an altitude of 37°, and this will be about the most favourable position for observation.

THE MINOR PLANETS.—That part of the *Berliner Astronomisches Jahrbuch* for 1887, containing its speciality, the ephemerides of the small planets for 1885, has been issued in advance of the publication of the volume. There are approximate places for every twentieth day of 237 out of the 244 now known, with accurately calculated opposition-ephemerides of 19. The most reliable elements of the orbits of these bodies to No. 237 inclusive are appended. *Æthra* continues at a distance of less than 1·0 from the earth until February 11, and if the orbit had been more closely determined, would have afforded a favourable opportunity of applying the method of finding the solar parallax suggested by Prof. Galle, as the planet has been a ninth magnitude at this opposition. *Eva*, *Stephania*, and *Agathe*, also approach the earth during the present year, within her mean distance from the sun; on August 10 *Stephania* will be at a distance of only 0·76, magnitude 11½.

Æthra has the least perihelion distance of the group, 1·604, while *Andromache*, with a considerable excentricity, has the greatest aphelion distance, 4·726, so that the orbits of the 244 planets extend over a space of 3·122, the earth's mean distance from the sun being taken as unity. The longest period of revolution occurs in the case of *Hilda*; it is yet doubtful which has the shortest period; No. 149 *Medusa* is credited with it at present, but until this member of the group has been re-observed, the point is perhaps doubtful. The most recently detected planet appears to have the shortest revolution next to *Medusa*, judging from the elements in the last circular of the *Berliner Jahrbuch*.

THE BRIGHTNESS OF SATURN.—Dr. G. Müller, of the Observatory at Potsdam, notifies in a recent number of the *Astronomische Nachrichten*, that since the year 1878 he has made regular photometric observations on Saturn, the main result of which he states to be, that when the earth is at an elevation of 26° above the plane of the ring, the planet's light is 2·4 times greater than when the earth is in that plane, or, in other words, that the brightness of Saturn's rings, when the earth is 26° from their plane, amounts to 58·3 per cent. of the brightness of the whole Saturnian system.

ENCKE'S COMET.—This comet appears to have been re-observed both in Europe and the United States; a somewhat doubtful observation by Dr. Tempel at Florence shows that the predicted elements will require probably but small correction. Taking aberration into account, the calculated position on December 13 differed from that observed, + 1′·1 in right ascension, and + 1′·2 in declination; the theoretical intensity of light on this date was 0·193. In 1852, when the perihelion passage occurred a week only later than in the present year, the comet was first observed on January 9, the intensity of light being 0·228.

GEOGRAPHICAL NOTES

THE lectures given under the auspices of the Paris Geographical Society last spring were so successful, that they are to be resumed this year. The first will be given by M. Janssen, on January 13, on the universal meridian. The others will be, by Prof. de Lapparent, on January 27, on the formation and development of the earth's crust; February 3, M. Bouquet de la Grye, the oceans; February 10, Dr. Hamy, man; March 3, M. Himly, the conquest of the globe; March 10, M. Levasseur, the riches of the globe; March 24, M. Louis Simonin, the great lines of navigation; March 31, M. Michel, railways and their relation to geography. These lectures are not free even to members, the charge for the course to such being fifteen francs, and twenty francs to outsiders. Some of the lectures will be illustrated with projections on the screen, and the success of the enterprise is so assured that a third series has already been arranged for in 1886.

MR. H. H. JOHNSTON writes as follows to the *Times*:—"The Kilimanjaro Expedition which I have just undertaken has resulted in a pleasant and healthy sojourn in one of the most beautiful and interesting regions in the world. I arrived at the mountain in the beginning of June, and settled first in Mandara's territory, on the southern slopes. Here I built a small town of about twenty houses and passed four months in collecting and making numberless excursions right and left. The climate was that of a Devonshire summer, provisions were abundant, cheap, and of great variety, and I was only fearful lest this delightful region might become to me a Capua, and deter me from the more important work that awaited me at a higher level than could be attained within the limits of Mandara's kingdom. Accordingly, when I had received from the coast a reinforcement of hardier men, I established myself at a height of 11,000 feet, and here built an even larger village than my settlement at Moshi. This was on a splendid site. A mountain torrent dashed past our circle of pretty thatched cottages, which surmounted a grassy knoll above the stream; to the south of us spread a wondrous prospect of sun-lit plains and distant rivers—a veritable map of Eastern Africa—and to the north rose the unspeakably grand summits of the mountain mass—Kibô, a dazzling dome of virgin white, and Kimawenzi, a piebald peak of black, jagged rocks, seamed and flecked with snow. From this settlement I constantly ascended as far as I was able in one day's journey, but the difficulties which lay in the way of a complete ascent of either peak arose from the impossibility of inducing any of my followers to accompany me beyond 14,000 feet, for above this altitude they suffered so keenly from cold and mountain sickness that no persuasion or bribes would induce them to ascend any higher, far less to carry any of my *impedimenta*. Consequently, I could never get beyond a certain distance from the settlement, the cold not permitting me to risk the chance of being benighted in the snow. I reached, however, an altitude of 16,200 feet, a little more than 2000 feet from the summit of Kibô, (18,800 feet high). I found warm springs at 14,400 feet, detected no signs of glacial action, and was somewhat disappointed with the paucity of plants growing at the snow line. Birds were very rare above 10,000 feet, and very abundant below. Lizards and chameleons existed (and frogs also) up to the very snow. Hyraxes (the hyrax is the coney of Scripture) were common between 8000 and 13,000 feet, and I fancy are represented by a new species. Buffaloes and elephants ascended to 14,000 feet. The thunderstorms that frequently rage round the upper slopes of the mountain are terrific, and the wind at times is so violent that no one can keep their feet. The natives who

inhabit Kilimanjaro up to 6000 feet, are fairly tractable, and have a passionate love of trade, which with them is the great pacifier. They go absolutely naked, or if any clothing is worn in the way of ornament it rarely goes beyond leather capes for the shoulders. They all speak dialects belonging to the great Bantu group of languages. I have studied carefully several of them, and have, I believe, discovered some most interesting points in their construction likely to throw considerable light on the archaic forms of Bantu prefixes. I may add that, after a very happy sojourn in the lovely forest region of Taveita at the foot of the mountain, I was compelled to return most reluctantly to the coast at the end of November owing to the exhaustion of my funds. I left Kilimanjaro with great regret, and on my homeward journey my thoughts were persistently directed to my whilom African home, rather than to an unwilling and too early return to civilisation. My collections have safely reached this country, and will, I hope, be sufficient to indicate the true character and relationships of the fauna and flora of Kilimanjaro."

The death is announced at Lübeck of Dr. Robert Avé-Lallemant, at one time a well-known traveller in South America. He became surgeon to the Novara expedition, which, however, he left at Rio, in order to devote himself to exploration in Brazil. In 1858 he went to Rio Grande do Sul, where he commenced his journey into Southern Brazil, during which he visited Bonpland, a few months before his death, in his lonely ranche in Paraguay. He crossed the Uruguay Allegrette, San Gabriel, and Cacupava to the Jacuy. From San José he went along the coast to Laguna, visited the sources of the Uruguay, and returned to San José through forests still unknown to travellers. This journey lasted about a year, and soon after his return he again set out to travel through the northern provinces. Landing at Bahia, he followed the coast to the Mucury river. Here he discovered the shocking condition of some of the German colonies. Thence he went to Pernambuco, and ascended the Amazon to Tabatinga, on the Peruvian frontier. On these journeys he published two large works ("Reise durch Süd Brasilien, 1859," and a similar work on North Brazil), and numerous smaller ones. They give no new geographical discoveries or exact measurements, or the results of scientific investigation, but they contain valuable information respecting the country, the fauna and flora, and condition of the people. The later years of his life were spent in medical practice in his native city.

According to *L'Exploration*, the Argentine authorities are sending an expedition to the Chaco. It consists of 200 men, divided into three columns, operating from different points, but meeting at Cangayé, a centre almost equally distant from Salta and Paraguay. The object is both military and scientific. It is desired to secure the possession of this vast territory to the Argentine Republic against the Indians, who are again masters there. Six topographical commissions are attached to the expedition in order to study the country, prepare maps, and also, it is said, to investigate the possibility of a railway as far as Oran, in the province of Salta. The investigation of the rivers, for which the gunboat *Pilcomayo* is sent, has been delayed by the low state of the water, but recent rains will now enable that work to be proceeded with. If the result should be the demonstration of the suitability of the *Pilcomayo* to navigation, not only will a great service be rendered to topographical science, but by assuring communications between Bolivia and the Rio Paraguay, a great economical revolution will, it is expected, be produced in these regions.

EXPERIMENTS SUITABLE FOR ILLUSTRATING ELEMENTARY INSTRUCTION IN CHEMISTRY

Professors Sir H. E. Roscoe and W. J. Russell, by direction of the Lords of the Committee of Council on Education, have recently prepared, for the assistance of teachers of science schools and classes, an outline of experiments in chemistry. As this subject is now under discussion, we are glad to be able to give the outline *in extenso* in Nature.

The notes have been prepared as some guide to the teachers as to the general character of the course of instruction expected in the elementary stage; they include instruction that should on no account be omitted, but must be considered rather as suggestive than exhaustive.

I.—*Combustion and Chemical Combination*

1. Burn a taper in a clean glass bottle. Show the presence of a colourless gas, differing in properties from common air by yielding a turbidity with lime-water.

2. Hold a bright glass over a burning candle and show the formation of water.

Explain what is meant by chemical change, and state that chemistry is an experimental science.

3. Make similar experiments with a petroleum or paraffin lamp.

4. Show that coal-gas also yields the same products by passing the products of combustion through lime-water and by collecting the water.

5. Explain the difference between mechanical mixture and chemical combination; and illustrate by a mixture of finely-divided copper and flour of sulphur, and the effect of heat upon the same.

6. Experiment to show that chemical change consists of a change in the properties of matter and that no loss of matter takes place. Suspend lamp chimney, partly filled with lumps of caustic soda, from the arm of a balance. Place short piece of candle in the lower part of the glass and counterbalance. Light the candle. Explain the increase in weight.

7. Heat is evolved when chemical combination takes place. Pour water on to quicklime. Refer also to experiments 1 and 3.

8. Combustibles and supporters of combustion. The purely relative character of these terms. Ordinary combustion the union of atmospheric oxygen with a body termed the combustible, or with one or more of its constituents, heat being developed, as in all cases where two or more bodies combine. Illustrate by showing that air will burn in coal-gas just as well as coal-gas will burn in air.

II.—*Air*

1. Existence of atmosphere, felt in winds.

2. Weight of air shown by means of a flask exhausted by the air-pump.

3. Burn phosphorus in air.

4. Burn phosphorus in confined volume of air and show diminution in bulk.

5. Show that some diminution takes place slowly when a stick of phosphorus is exposed to air at ordinary temperatures.

6. Test residual gas (N) with a burning taper.

7. Show that phosphorus burnt in air increases in weight.

8. Allow iron borings moistened with sal ammoniac to rust in a confined volume of air and introduce burning taper into residual gas (N).

9. Show that iron filings, suspended by a magnet hanging on one scale of a balance, increase in weight on heating.

10. Strongly heat the red substance which may be formed by gently heating mercury in the air. Collect and test the gas (O) with a glowing splinter of wood.

11. Add the gas thus obtained to the residue obtained in experiment 4 or 8 so as to make up the original volume of air, and show that a taper burns in this mixture as in common air.

12. Refer to numbers giving exact analysis of air, calling especial attention to the fact that it varies slightly in composition.

Also explain that no obvious change, such as increase of temperature or alteration of bulk, occurs when oxygen and nitrogen are mixed. Also that air has the properties of a mixture, and that when water is shaken up with air a portion of that air dissolves, the residue being found to contain relatively less oxygen than the original air, whilst the dissolved portion contains relatively more oxygen, and that this could not be the case if the air were a compound. Consequently it is a mixture and not a chemical compound.

13. It is important that these experiments should be made and their explanation given so as to teach the student how the composition of air is ascertained by experiment, and in a similar manner how oxygen was discovered by Priestley, and how the composition of the air and the part which oxygen plays in the phenomena of combustion were experimentally demonstrated by Lavoisier.

III.—*Effects of Animal and Vegetable Life upon the Atmosphere*

1. Show that by drawing air into the lungs through lime-water a very faint, if any, precipitate is produced; but that on expiring air from the lungs through another portion of lime-water a copious precipitate is soon formed.

2. Show the production of carbon dioxide by the oxidation of ordinary articles of food, as by heating small quantities of the dried substance, such as sugar, bread, or meat, with copper oxide.

3. Show that carbon dioxide exists in the air by pouring clear lime-water into a shallow vessel exposed to air, and explain that this small quantity of carbon dioxide serves as the main food of the plants that grow on the earth.

4. Expel air from water by boiling, and explain how fish and aquatic plants are thus provided with oxygen and carbonic acid.

5. Explain that plants eliminate and animals require oxygen. That animals take in oxygen from the air, and give out carbonic acid. That plants possess the power under the influence of light of assimilating carbon from carbon dioxide and liberating the oxygen. Explain that thus the balance of oxygen and carbon dioxide in the atmosphere is maintained.

6. Illustrate the action of plants by the formation of bubbles of oxygen when a fresh plant is exposed to the action of light in water containing carbonic acid in solution.

IV.—*Water*

1. Illustrate the three states of matter, the solid, the liquid, and the gaseous, with ice, water, and steam, and point out that the difference is caused by increase or diminution in the amount of heat present.

2. Composition of water. Decompose water by the electric current. Collect the two gases separately in a voltameter, and exhibit their properties.

3. Show formation of water by explosion of a mixture of hydrogen (two volumes) and oxygen (one volume) in a soda-water bottle.

4. Explode soap-bubbles inflated by a mixture of hydrogen and oxygen in the above proportions.

5. Throw potassium or sodium into water, and collect the hydrogen.

6. Pass steam over red-hot iron, collect the gas and show that it is hydrogen.

7. Show that the same gas may be obtained by dissolving zinc clippings or iron turnings in dilute sulphuric acid.

8. Demonstrate the properties of hydrogen :
 (*a*) Its combustibility.
 (*b*) Its lightness.
 (*c*) That a candle will not burn in it.
 (*d*) That water is formed when it burns in air.

9. Composition of water. Pass oxygen over red-hot copper, and show by weighing before and after that the weight increases.

10. Pass hydrogen over the copper oxide thus produced, heating gently. Collect the water, and show that the copper oxide has been entirely reduced, the tube weighing the same as before passing the oxygen through it.

11. Determine the composition of water by weight by passing dry hydrogen over half an ounce of copper oxide, and collecting the water in a weighed chloride of calcium tube. Show approximately that water contains two parts by weight of hydrogen to sixteen parts by weight of oxygen.

12. Note the first law of chemical combination : that chemical compounds, such as water, always contain their components in the same unvarying proportions.

13. Contrast the properties of water with those of its constituents on the one hand, and the properties of air with those of its constituents on the other.

14. Call attention to air and water as illustrations of the difference between a mixture and a compound, and quote oxygen, nitrogen, and hydrogen as examples of elementary bodies.

15. Separation of impurities from water by filtration and distillation. Preparation of fresh water from salt water.

16. Experiments illustrating solution and crystallisation. Soluble substances, as sugar, washing soda, alum ; slightly soluble substances, as gypsum or plaster of Paris ; insoluble substances, as chalk, flint, and sand.

17. Crystallise carbonate of soda, and sulphate of copper.

V.—*Oxygen and Ozone*

1. Prepare oxygen by heating
 (*a*) Oxide of mercury.
 (*b*) Potassium chlorate.
 (*c*) Mixture of potassium chlorate, and either manganese dioxide, copper oxide, or ferric oxide.

2. Show the re-ignition of a splinter of red-hot wood and glowing wick of taper.

3. Burn charcoal in oxygen, and show the formation of carbon dioxide.

4. Burn phosphorus simultaneously in air and in oxygen.

5. Burn watch-spring in oxygen.

6. Show that iron does not rust in dry oxygen.

7. *Ozone.*—Describe and demonstrate the formation of ozone by submitting oxygen to the silent electric discharge.

8. Describe and demonstrate the properties of ozone which distinguish it from ordinary oxygen, such as its action on metallic mercury, on indigo solution, or on potassium iodide and starch. Also its change to ordinary oxygen when passed through a heated glass tube.

9. Explain the difference in density between oxygen and ozone.

VI.—*Combining Weights ; Names and Symbols of the Elements ; Chemical Calculations, &c.*

1. Exhibit list of the elements, distinguishing (by means of the type) the non-metals from the metals ; and, again, the more commonly occurring metals from those which are rarer.

2. Describe the occurrence of these elements in the air, in the sea, and in the solid crust of the earth.

3. Write up the results of the quantitative analysis of potassium chlorate. Explain that this is the result of experiment, and demonstrate the fact that, when heated, an unalterable weight of oxygen is given off and a given unalterable weight of potassium chloride remains behind.

4. Dissolve a crystal of pure chlorate of potassium, and the residue of chloride from heating chlorate, in two separate glasses, and show the difference in the reaction with silver chloride.

5. Explain the meaning of the term chemical symbol, and chemical formula of the salt, referring afterwards to the combining weights of the elements.

6. Explain the mode of determining the formula from the percentage composition.

7. Method of calculating the quantity of oxygen from potassium chlorate (and from manganese dioxide).

VII.—*Acids, Bases, and Salts*

1. Burn sodium in oxygen ; dissolve the product in water ; give the formula of the oxide. Express the action of water upon it by an equation.

2. Act on water with sodium, and collect the hydrogen. Explain by equation that the same substance, sodium hydrate or hydroxide, or caustic soda, is formed, as in experiment 1.

3. Burn sulphur in a current of oxygen, and show the product fumes slightly in the air. Explain that it is a mixture of sulphur dioxide and trioxide. Pass the gas thus obtained into water.

4. Add litmus solution to the solutions obtained in experiments 2 and 3, and show that on adding the one solution to the other the colour is changed, or a point is reached where a further addition of the one has no effect, whereas a minute addition of the other at once changes the colour. Explain the action by an equation.

5. Explain that the compound formed from the sodium oxide and water is termed an alkali, or alkaline or basic hydroxide, and the oxide from which it is formed an alkaline or basic oxide ; that the compound formed from the sulphur dioxide and water is termed an acid hydroxide or acid, and the original oxide an acid forming oxide or anhydride.

6. Explain that sodium hydroxide and sulphurous acid may be taken as representative of the two classes into which hydroxides are divided.

7. Explain that by the action of the one upon the other a salt is formed. Exhibit a white crystalline salt, *e.g.* sodium sulphate.

VIII.—*Hydrogen*

1. Prepare hydrogen by the action of dilute sulphuric acid on zinc.

2. Show that it is not obtained by the use of pure zinc (amalgamated zinc is best used), and illustrate the effect of impurity by adding a drop or two of a lead or copper salt.

3. Prepare hydrogen by dissolving zinc or aluminium in sodium hydroxide.

4. Point out that whereas sodium displaces hydrogen from water at ordinary temperature, and that iron does so at a red heat, copper is without any action at any temperature.

5. Give equations for the various methods here indicated for obtaining hydrogen.[1]

6. Explain fully in detail the methods of chemical calculation, and make the pupils thoroughly understand the methods of calculating quantities.

7. Demonstrate the physical properties of hydrogen, especially its lightness and diffusibility.

8. Compare the heating powers of jet of hydrogen burning in air and in oxygen. Explain the difference.

9. Describe and (if possible) demonstrate the construction and use of the oxy-hydrogen blowpipe.

10. Explain what is meant by heat of combustion, and define the term "heat-unit." Show for this purpose side by side 18 grammes of water and the quantity of water which would be raised 1° C. in temperature by the heat developed in the formation of this quantity of water from its elements.

11. Point out that hydrogen is a powerful reducing agent, illustrating this by the reduction of oxide of iron.

12. Show that nascent hydrogen, or hydrogen at the moment of its liberation from its compounds, frequently produces effects that hydrogen in the free state does not. Bubble hydrogen through ferric chloride solution and show that no discolorisation takes place. Place it in contact with zinc and dilute sulphuric acid and the colour disappears.

13. Explain the term nascent as applied to hydrogen and other gas at the moment of its liberation from one of its compounds, and distinguish between the atom of nascent hydrogen and the molecule of free hydrogen.

IX.—*Hydrochloric Acid and Chlorine*

1. Explain with equation and show the action of sulphuric acid on common salt. Collect the escaping gas by downward displacement and show its solubility in water.

2. Hold piece of paper dipped in ammonia solution in the gas.

3. Saturate water with the gas, noting that its volume increases and that considerable heat is developed.

4. Exhibit the effects produced by adding the solution to litmus and to silver nitrate solution.

5. Show that it has no action on indigo, or on a mixture of potassium iodide and starch solution.

6. Pass the gas over red-hot iron and show the production of hydrogen.

7. *Chlorine.*—Heat oxide of manganese with the solution of hydrochloric acid obtained in experiment 3, and collect several jars of the escaping chlorine by downward displacement. Give the equation.

8. Pass some of the gas into water. Exhibit the yellow colour of the solution and show that it precipitates silver nitrate and bleaches litmus and indigo.

9. Burn a jet of hydrogen in chlorine. Show the disappearance of the yellow-coloured gas.

10. Moisten some paper with a few drops of turpentine and throw it into a jar of chlorine. Point out the formation of hydrochloric acid and the deposition of carbon.

11. Explode a mixture of equal volumes of hydrogen and chlorine.

12. Point out how these experiments show that the gas produced in experiment 1 is a compound of chlorine and hydrogen. Give the symbol and atomic weight of chlorine, and state the composition of hydrochloric acid gas by weight and volume.

13. Explain the production of chlorine from common salt, sulphuric acid, and manganese dioxide. Give equations, and instruct the students in the calculations of quantities.

14. Show the combustion in chlorine, of phosphorus, antimony, and copper, and demonstrate its power to displace bromine and iodine from their compounds with metals.

15. Electrolysis of hydrochloric acid solution, and explain the fact of the evolution of equal volumes of its constituent gases.

16. Explain the bleaching action of chlorine as being due to the readiness with which it combines with hydrogen and that it thus acts as an oxidising agent. In illustration of this, show that a piece of dry turkey red cloth when placed in dry chlorine is not bleached.

X.—*Nitrogen and Ammonia*

1. The production of nitrogen from the air and the examination of its properties may here be repeated.

2. Describe and (if possible) demonstrate the production of ammonia by passing sparks from an induction coil or electric machine through a mixture of nitrogen and hydrogen. Explain that the reaction is not complete unless the ammonia is withdrawn as it is formed, owing to the fact that ammonia is readily decomposed by heat.

3. Prepare ammonia by heating an ammoniacal salt with slaked lime. Collect by upward displacement and over mercury, and show extreme solubility in water.

4. Demonstrate and explain its combination with hydrochloric acid, and show the volatility of sal ammoniac.

5. Show that the aqueous solution of ammonia behaves in the same way as a solution of sodium hydroxide, turning red litmus blue, neutralising acids, and forming precipitates in solutions of metals (copper, iron, and zinc salts, for example) of the same composition as those produced by sodium hydroxide. Explain that on this account it is considered that the ammonia solution contains ammonium hydroxide.

6. Pass dry ammonia gas over red-hot copper oxide and show the production of water and metallic copper.

7. Pass air and ammonia gas simultaneously over red-hot copper as a method of preparing nitrogen.

XI.—*Nitric Acid and the Oxides of Nitrogen*

1. Explain on the blackboard the composition by weight of the five distinct oxides of nitrogen as illustrative of the law of chemical combination in multiple proportions, and as a deduction from this, explain Dalton's atomic theory and state clearly what is meant by an atom. Demonstrate with a series of blocks labelled with the symbols of the different elements how this explains the observed facts of combination in multiple proportions.

2. Make clear to the student the difference between atom and molecule, and explain atomic weight and molecular weight of (1) hydrogen; (2) oxygen, ozone; (3) chlorine; and then of compounds such as (4) hydrochloric acid; (5) water; (6) ammonia.

3. Describe and (if possible) demonstrate the formation of the red fumes of nitric peroxide on passing an electric spark through air.

4. Preparation of nitric acid from nitre and sulphuric acid. Explain the reaction by an equation.

5. Calculation of quantities to be carefully gone into.

6. Exhibit nitre, nitrate of soda, sulphate and bisulphate of potash, and sulphate and bisulphate of soda.

7. Show the oxidising action of nitric acid by dropping it on to some red-hot charcoal.

8. Oxidising action of nitric acid on metallic tin and metallic copper.

8A. Deflagrate mixture of nitre and charcoal.

9. Show the decomposition of nitric acid when heated by dropping it into the bowl of a clay tobacco pipe, the stem of which is strongly heated, collecting the gas over water and testing with a flaming splinter of wood.

10. Heat potassium nitrate and collect the gas (O).

11. Prepare nitric oxide from residue in experiment 10 by treating with dilute sulphuric acid. Explain decomposition o nitrous acid into nitric oxide and nitric acid.

12. Prepare nitric oxide by action of nitric acid on copper turnings. Collect the gas. Explain the reaction.

13. Exhibit the direct combination of nitric oxide with oxygen. Note the formation of red fumes of nitrogen peroxide and their immediate absorption by water.

14. Show that flame of a taper is extinguished in nitric oxide, and that feebly burning phosphorus is also extinguished, but that brightly burning phosphorus continues to burn, and with greater brilliance than in ordinary air. Explain this.

15. Preparation of nitrous oxide. Neutralise nitric acid with ammonia. Evaporate the solution and obtain the solid salt. Show the preparation of nitrous oxide with this residue. Collect the gas over warm water. Give equation. Explain that nitrous oxide is readily soluble in cold water.

16. Show that like oxygen, nitrous oxide supports the combustion of a taper, and explain that this is caused by the decomposition of the gas, and the union of the constituents of the taper with the oxygen of the nitrous oxide, and liberation of the nitrogen.

17. Also show that phosphorus and strongly ignited sulphur burn in the gas, but that feebly ignited sulphur is extinguished. Explain this.

18. Point out the distinction between nitrous oxide and oxygen: (1) the solubility of nitrous oxide in cold water, (2) the production of nitrogen when bodies burn in it, (3) the fact that nitric oxide does not produce with it red fumes, as is the case with oxygen.

19. Prepare nitrogen from ammonium nitrite (*i.e.* a mixture of potassium nitrite and ammonium chloride).

20. Explain how, in the above experiments, the gradual deoxidation of nitric acid yields the several oxides of nitrogen, and lastly, nitrogen itself.

XII.—*Sulphur*

1. Exhibit the different forms of sulphur: flour of sulphur, brimstone or stick sulphur, and crystallised native sulphur.

2. Dissolve sulphur in bisulphide of carbon, and obtain crystals by spontaneous evaporation. Indicate the identity of this form with the naturally occurring crystals, and its difference from that obtained by fusing sulphur and allowing the mass to cool.

3. Explain what is meant by allotropic modification, and point out how the one form of crystal passes into the other.

4. Show the effect of heat upon sulphur melted in a flask. Contrast the brittle mass derived from cooling the sulphur after heating slightly above its melting-point by pouring into cold water, with the plastic mass obtained when cooled in the same way from a high temperature. Point out the changes which occur as the temperature rises, and exhibit the red vapour of sulphur.

5. Show combustion in sulphur vapour. Insert a coil of copper wire into the sulphur vapour, and show that combination occurs.

6. Distil sulphur in a small retort.

7. Pass hydrogen through boiling sulphur, and demonstrate the formation of hydrogen sulphide by its blackening action on lead paper.

8. Exhibit ferrous sulphide and galena (lead sulphide). Prepare hydrogen sulphide (sulphuretted hydrogen) from the former by the action of dilute sulphuric acid. Collect by displacement and prepare a solution of the gas in water.

9. Show the combustible nature of hydrogen sulphide by burning a jar of the gas, and point out the deposition of sulphur due to incomplete combustion. Demonstrate and explain the decomposition of hydrogen sulphide by chlorine, and show the deposition of sulphur when its solution is allowed to stand exposed to the air and light.

10. Demonstrate the value of hydrogen sulphide as a means of separating the metals into groups, by adding the solution or passing the gas into solutions of the various metals, as, for example, arsenious acid, copper sulphate, lead nitrate, antimony chloride, zinc sulphate, ferrous sulphate, and magnesium sulphate.

Write down the equations in each case.

11. Prepare sulphur dioxide by heating copper with sulphuric acid and collect the gas.

12. Illustrate the condensation of a gas into a liquid by passing sulphur dioxide into a glass tube surrounded by a freezing mixture of ice and salt.

13. Pass the gas into water and demonstrate the acid properties of the solution.

14. Prepare sulphur trioxide from fuming Nordhausen sulphuric acid. Add it to water and compare its behaviour with that of the dioxide under similar circumstances.

15. Describe the formation in the above experiment of sulphuric acid, explain the properties of oil of vitriol, demonstrating its affinity for water as exhibited by the great heat evolved when the two liquids are mixed.

16. Explain the barium chloride test for sulphuric acid.

17. Add barium chloride to a solution of sulphurous acid, and then nitric acid.

18. Explain that in consequence of the readiness with which sulphurous acid takes up oxygen it acts as a bleaching agent and as a powerful reducing agent.

XIII.—*Carbon*

1. Show the presence of carbon (charcoal) in wood by carbonising a splinter of wood in a test-tube; and in white sugar by pouring strong sulphuric acid on to a syrupy solution.

2. Describe the properties and modes of occurrence of the three allotropic modifications of carbon: (*a*) the amorphous form (lamp-black and charcoal), and the two crystalline forms, (*b*) graphite, and (*c*) diamond. Describe the octahedral forms of the crystal of diamond and show glass or wood models.

3. Explain that the same weight of each of these substances when burnt gives the same weight of the same product (carbon dioxide).

4. Calculate the weight of carbon dioxide obtained from a given weight of any one of these forms.

5. Prepare carbon dioxide by treating chalk or carbonate of soda (washing soda) with an acid. Prove that the gas thus obtained really obtains carbon by heating a pellet of potassium in the dry gas contained in a small flask.

6. Demonstrate the high specific gravity of carbon dioxide by pouring it from one vessel to another, and showing that it extinguishes a taper.

7. Pass carbon dioxide over red-hot carbon in an iron tube, and show that it loses a part of its oxygen and is converted into carbon monoxide, a combustible gas, which, on combustion, again yields carbon dioxide. Collect the carbon monoxide over water containing caustic soda, and show that the gas does not render lime-water turbid. Then burn it, and show that the residual gas does possess this power.

8. Pass carbon monoxide over red-hot copper oxide to show the formation of carbon dioxide, and explain the use of carbon monoxide as a reducing agent in metallurgical operations.

9. Explain the changes which take place in an ordinary coal fire. Mention the poisonous nature of the carbon monoxide, and state that it is formed in cases of incomplete combustion from insufficient supply of oxygen.

10. Mention heat of combustion of carbon, and of carbon monoxide, and explain the value of the latter as a fuel.

11. Explain the reaction which takes place when carbon dioxide is passed into caustic soda and into lime-water, and explain the formation of a soluble carbonate in the first, and an insoluble carbonate in the second case.

CHARACTERISTICS OF THE NORTH AMERICAN FLORA[1]

WHEN the British Association, with much painstaking, honours and gratifies the cultivators of science on this side of the ocean by meeting on American soil, it is but seemly that a Corresponding Member for the third of a century should endeavour to manifest his interest in the occasion and to render some service, if he can, to his fellow-naturalists in Section D. I would attempt to do so by pointing out, in a general way, some of the characteristic features of the vegetation of the country which they have come to visit,—a country of "magnificent distances," but of which some vistas may be had by those who can use the facilities which are offered for enjoying them. Even to those who cannot command the time for distant excursions, and to some who may know little or nothing of botany, the sketch which I offer may not be altogether uninteresting. But I naturally address myself to the botanists of the Association, to those who, having crossed the wide Atlantic, are now invited to proceed westward over an almost equal breadth of land; some, indeed, have already journeyed to the Pacific coast, and have returned; and not a few, it is hoped, may accept the invitation to Philadelphia, where a warm welcome awaits them—warmth of hospitality, rather than of summer temperature, let us hope; but Philadelphia is proverbial for both There opportunities may be afforded for a passing acquaintance with the botany of the Atlantic border of the United States, in company with the botanists of the American Association, who are expected to muster in full force.

What may be asked of me, then, is to portray certain outlines of the vegetation of the United States and the Canadian Dominion, as contrasted with that of Europe; perhaps also to touch upon the causes or anterior conditions to which much of the actual differences between the two floras may be ascribed. For indeed, however interesting or curious the facts of the case may be in themselves, they become far more instructive when we attain to some clear conception of the dependent relation of the present vegetation to a preceding state of things, out of which it has come.

As to the Atlantic border on which we stand, probably the first impression made upon the botanist or other observer coming from Great Britain to New England or Canadian shores, will be the similarity of what he here finds with what he left behind. Among the trees the White Birch and the Chestnut will be identified, if not as exactly the same, yet with only slight differences—differences which may be said to be no more essential or profound than those in accent and intonation between the British

[1] An Address to the Botanists of the British Association for the Advancement of Science; read at Montreal to the Biological Section, August 29, 1884, by Prof. Asa Gray.

speech and that of the "Americans." The differences between the Beeches and Larches of the two countries are a little more accentuated; and still more those of the Hornbeams, Elms, and the nearest resembling Oaks. And so of several other trees. Only as you proceed westward and southward will the differences overpower the similarities, which still are met with.

In the fields and along open roadsides the likeness seems to be greater. But much of this likeness is the unconscious work of man, rather than of Nature, the reason of which is not far to seek. This was a region of forest, upon which the aborigines, although they here and there opened patches of land for cultivation, had made no permanent encroachment. Not very much of the herbaceous or other low undergrowth of this forest could bear exposure to the fervid summer's sun; and the change was too abrupt for adaptive modification. The plains and prairies of the great Mississippi Valley were then too remote for their vegetation to compete for the vacancy which was made here when forest was changed to grain-fields and then to meadow and pasture. And so the vacancy came to be filled in a notable measure by agrestial plants from Europe, the seeds of which came in seed-grain, in the coats and fleece and in the imported fodder of cattle and sheep, and in the various but not always apparent ways in which agricultural and commercial people unwittingly convey the plants and animals of one country to another. So, while an agricultural people displaced the aborigines which the forest sheltered and nourished, the herbs, purposely or accidentally brought with them, took possession of the clearings, and prevailed more or less over the native and rightful heirs to the soil,—not enough to supplant them, indeed, but enough to impart a certain adventitious Old World aspect to the fields and other open grounds, as well as to the precincts of habitations. In spring-time you would have seen the fields of this district yellow with European Buttercups and Dandelions, then whitened with the Ox-eye Daisy, and at midsummer brightened by the cærulean blue of Chicory. I can hardly name any native herbs which *in the fields and at the season* can vie with these intruders in floral show. The common Barberry of the Old World is an early denizen of New England. The tall Mullein, of a wholly alien race, shoots up in every pasture and new clearing, accompanied by the common Thistle, while another imported Thistle, called in the States "the Canada Thistle," has become a veritable nuisance, at which much legislation has been levelled in vain.

According to tradition the wayside Plantain was called by the American Indian "White-Man's foot," from its springing up wherever that foot had been planted. But there is some reason for suspecting that the Indian's ancestors brought it to this continent. Moreover there is another reason for surmising that this long-accepted tradition is factitious. For there was already in the country a native Plantain, so like *Plantago major* that the botanists have only of late distinguished it. (I acknowledge my share in the oversight.) Possibly, although the botanists were at fault, the aborigines may have known the difference. The cows are said to know it. For a brother botanist of long experience tells me that, where the two grow together, cows freely feed upon the undoubtedly native species, and leave the naturalised one untouched.

It has been maintained that the ruderal and agrestial Old World plants and weeds of cultivation displace the indigenous ones of newly-settled countries in virtue of a strength which they have developed through survival in the struggle of ages, under the severe competition incident to their former migrations. And it does seem that most of the pertinacious weeds of the Old World which have been given to us may not be indigenous even to Europe, at least to Western Europe, but belong to campestrine or unwooded regions farther east; and that, following the movements of pastoral and agricultural people, they may have played somewhat the same part in the once forest-clad Western Europe that they have been playing here. But it is unnecessary to build much upon the possibly fallacious idea of increased strength gained by competition. Opportunity may count for more than exceptional vigour; and the cases in which foreign plants have shown such superiority are mainly those in which a forest-destroying people have brought upon newly-bared soil the seeds of an open-ground vegetation.

The one marked exception that I know of, the case of recent and abundant influx of this class of Old World plants into a naturally treeless region, supports the same conclusion. Our associate, Mr. John Ball, has recently called attention to it. The pampas of South-Eastern South America beyond the Rio Colorado, lying between the same parallels of latitude in the south as Montreal and Philadelphia in the north, and with climate and probably soils fit to sustain a varied vegetation, and even a fair proportion of forest, are not only treeless, but excessively poor in their herbaceous flora. The district has had no trees since its comparatively recent elevation from the sea. As Mr. Darwin long ago intimated: "Trees are absent not because they cannot grow and thrive, but because the only country from which they could have been derived—tropical and sub-tropical South America—could not supply species to suit the soil and climate." And as to the herbaceous and frutescent species, to continue the extract from Mr. Ball's instructive paper recently published in the Linnean Society's *Journal*, "in a district raised from the sea during the latest geological period, and bounded on the west by a great mountain-range mainly clothed with an alpine flora requiring the protection of snow in winter, and on the north by a warm temperate region whose flora is mainly of modified sub-tropical origin—the only plants that could occupy the newly-formed region were the comparatively few which, though developed under very different conditions, were sufficiently tolerant of change to adapt themselves to the new environment. The flora is poor, not because the land cannot support a richer one, but because the only regions from which a large population could be derived are inhabited by races unfit for emigration."

Singularly enough, this deficiency of herbaceous plants is being supplied from Europe, and the in-comers are spreading with great rapidity; for lack of other forest material even apple-trees are running wild and forming extensive groves. Men and cattle are, as usual, the agents of dissemination. But colonising plants are filling, in this instance, a vacancy which was left by Nature, while ours was made by man. We may agree with Mr. Ball in the opinion that the rapidity with which the intrusive plants have spread in this part of South America "is to be accounted for, less by any special fitness of the immigrant species, than by the fact that the ground is to a great extent unoccupied."

The principle applies here also; and in general, that it is opportunity rather than specially acquired vigour that has given Old World weeds an advantage may be inferred from the behaviour of our weeds indigenous to the country, the plants of the unwooded districts—prairies or savannas west and south—which, now that the way is open, are coming in one by one into these eastern parts, extending their area continually, and holding their ground quite as pertinaciously as the immigrant denizens. Almost every year gives new examples of the immigration of campestrine western plants into the Eastern States. They are well up to the spirit of the age: they travel by railway. The seeds are transported, some in the coats of cattle and sheep on the way to market, others in the food which supports them on the journey, and many in a way which you might not suspect, until you consider that these great roads run east and west, that the prevalent winds are from the west, that a freight-train left unguarded was not long ago blown on for more than one hundred miles before it could be stopped, not altogether on down grades, and that the bared and mostly unkempt borders of these railways form capital seed-beds and nursery-grounds for such plants.

Returning now from this side-issue, let me advert to another and, I judge, a very pleasant experience which the botanist and the cultivator may have on first visiting the American shores. At almost every step he comes upon old acquaintances, upon shrubs and trees and flowering herbs, mostly peculiar to this country, but with which he is familiar in the grounds and gardens of his home. Great Britain is especially hospitable to American trees and shrubs. There those both of the eastern and western sides of our continent flourish side by side. Here they almost wholly refuse such association. But the most familiar and longest-established representatives of our flora (certain western annuals excepted) were drawn from the Atlantic coast. Among them are the Virginia Creeper or Ampelopsis, almost as commonly grown in Europe as here, and which, I think, displays its autumnal crimson as brightly there as along the borders of its native woods where you will everywhere meet with it; the Red and Sugar Maples, which give the notable autumnal glow to our northern woods, but rarely make much show in Europe, perhaps for lack of sharp contrast between summer and autumn; the ornamental Ericaceous shrubs, Kalmias, Azaleas, Rhododendrons, and the like, specially called American plants in England, although all the Rhododendrons of the finer sort are half Asiatic, the hardy American species

having been crossed and recrossed with more elegant but tender Indian species.

As to flowering herbs, somewhat of the delight with which an American first gathers wild Primroses and Cowslips and Foxgloves and Daisies in Europe, may be enjoyed by the European botanist when he comes upon our Trilliums and Sanguinaria, Cypripediums and Dodecatheon, our species of Phlox, Coreopsis, &c., so familiar in his gardens; or when, crossing the continent, he comes upon large tracts of ground yellow with Eschscholtzia or blue with Nemophilas. But with a sentimental difference: in that Primroses, Daisies, and Heaths, like nightingales and larks, are inwrought into our common literature and poetry, whereas our native flowers and birds, if not altogether unsung, have attained at the most to only local celebrity.

Turning now from similarities, and from that which interchange has made familiar, to that which is different or peculiar, I suppose that an observant botanist upon a survey of the Atlantic border of North America (which naturally first and mainly attracts our attention) would be impressed by the comparative wealth of this flora in trees and shrubs. Not so much so in the Canadian Dominion, at least in its eastern part; but even here the difference will be striking enough on comparing Canada with Great Britain.

The Coniferæ native to the British Islands are one Pine, one Juniper, and a Yew; those of Canada proper are four or five Pines, four Firs, a Larch, an Arbor-Vitæ, three Junipers, and a Yew—fourteen or fifteen to three. Of Amentaceous trees and shrubs, Great Britain counts one Oak (in two marked forms), a Beech, a Hazel, a Hornbeam, two Birches, an Alder, a Myrica, eighteen Willows, and two Poplars—twenty-eight species in nine genera, and under four natural orders. In Canada there are at least eight Oaks, a Chestnut, a Beech, two Hazels, two Hornbeams of distinct genera, six Birches, two Alders, about fourteen Willows and five Poplars, also a Plane tree, two Walnuts, and four Hickories; say forty-eight species, in thirteen genera, and belonging to seven natural orders. The comparison may not be altogether fair; for the British flora is exceptionally poor, even for islands so situated. But if we extend it to Scandinavia, so as to have a continental and an equivalent area, the native Coniferæ would be augmented only by one Fir, the Amentaceæ by several more Willows, a Poplar, and one or two more Birches;—no additional orders nor genera.

If we take in the Atlantic United States, east of the Mississippi, and compare this area with Europe, we should find the species and the types increasing as we proceed southward, but about the same numerical proportion would hold.

But more interesting than this numerical preponderance—which is practically confined to the trees and shrubs—will be the extra-European types, which, intermixed with familiar Old World forms, give peculiar features to the North American flora—features discernible in Canada, but more and more prominent as we proceed southward. Still confining our survey to the Atlantic district, that is, without crossing the Mississippi, the following are among the notable points:—

(1) Leguminous trees of peculiar types. Europe abounds in Leguminous shrubs or under-shrubs, mostly of the Genisteous tribe, which is wanting in all North America, but has no Leguminous tree of more pretence than the Cercis and Laburnum. Our Atlantic forest is distinguished by a Cercis of its own, three species of Locust, two of them fine trees, and two Honey Locusts, the beautiful Cladrastis, and the stately Gymnocladus. Only the Cercis has any European relationship. For relatives of the others we must look to the Chino-Japanese region.

(2) The great development of the Ericaceæ (taking the order in its widest sense), along with the absence of the Ericeous tribe, that is, of the Heaths themselves. We possess on this side of the Mississippi 30 genera and not far from 90 species. All Europe has only 17 genera and barely 50 species. We have most of the actual European species, excepting their Rhododendrons and their Heaths,—and even the latter are represented by some scattered patches of Calluna, of which it may be still doubtful whether they are chance introductions or sparse and scanty survivals; and besides we have a wealth of peculiar genera and species. Among them the most notable in an ornamental point of view are the Rhododendrons, Azaleas, Kalmias, Andromedas, and Clethras; in botanical interest, the endemic Monotropeæ, of which there is only one species in Europe, but seven genera in North America, all but one absolutely peculiar; and, in edible as well as botanical interest, the unexampled development and diversification of the genus Vaccinium (along with the allied American type, Gaylussacia) will attract attention. It is interesting to note the rapid falling away of Ericaceæ westward in the valley of the Mississippi as the forest thins out.

(3) The wealth of this flora in Compositæ is a most obvious feature,—one especially prominent at this season of the year, when the open grounds are becoming golden with Solidago, and the earlier of the autumnal Asters are beginning to blossom. The Compositæ form the largest order of Phænogamous plants in all temperate floras of the northern hemisphere, are well up to the average in Europe, but are nowhere so numerous as in North America, where they form an eighth part of the whole. But the contrast between the Compositæ of Europe and Atlantic North America is striking. Europe runs to Thistles, to Inuloideæ, to Anthemideæ, and to Cichoriaceæ. It has very few Asters and only two Solidagoes, no Sunflowers, and hardly anything of that tribe. Our Atlantic flora surpasses all the world in Asters and Solidagoes, as also in Sunflowers and their various allies, is rich in Eupatoriaceæ, of which Europe has extremely few, and is well supplied with Vernoniaceæ and Helenioideæ of which she has none; but is scanty in all the groups that predominate in Europe. I may remark that if our larger and most troublesome genera, such as Solidago and Aster, were treated in our systematic works even in the way that Nyman has treated Hieracium in Europe, the species of these two genera (now numbering 78 and 124 respectively) would be at least doubled.

(4) Perhaps the most interesting contrast between the flora of Europe and that of the eastern border of North America is in the number of generic and even ordinal types here met with which are wholly absent from Europe. Possibly we may distinguish these into two sets of differing history. One will represent a tropical element, more or less transformed, which has probably acquired or been able to hold its position so far north in virtue of our high summer temperature. (In this whole survey the peninsula of Florida is left out of view, regarding its botany as essentially Bahaman and Cuban, with a certain admixture of northern elements.) To the first type I refer such trees and shrubs as Asimina, sole representative of the Anonaceæ out of the tropics, and reaching even to lat. 42°; Chrysobalanus, representing a tropical sub-order; Pinckneya, representing as far north as Georgia the Cinchoneous tribe; the Baccharis of our coast, reaching even to New England; Cyrilla and Cliftonia, the former actually West Indian; Bumelia, representing the tropical order Sapotaceæ; Bignonia and Tecoma of the Bignoniaceæ; Forestiera in Oleaceæ; Persea of the Laurineæ; and finally the Cactaceæ. Among the herbaceous plants of this set I will allude only to some of peculiar orders. Among them I reckon Sarracenia, of which the only extra-North American representative is tropical American, the Melastomaceæ, represented by Rhexia; Passiflora (our species being herbaceous), a few representatives of Loasaceæ and Turneraceæ, also of Hydrophyllaceæ: our two genera of Burmanniaceæ; three genera of Hæmodoraceæ; Tillandsia in Bromeliaceæ; two genera of Pontederiaceæ; two of Commelynaceæ; the outlying Mayaca and Xyris, and three genera of Eriocaulonaceæ. I do not forget that one of our species of Eriocaulon occurs on the west coast of Ireland and in Skye, wonderfully out of place, though on this side of the Atlantic it reaches Newfoundland. It may be a survival in the Old World; but it is more probably of chance introduction.

The other set of extra-European types, characteristic of the Atlantic North American flora, is very notable. According to a view which I have much and for a long while insisted on, it may be said to represent a certain portion of the once rather uniform flora of the Arctic and less boreal zone, from the late Tertiary down to the incoming of the Glacial period, and which, brought down to our lower latitudes by the gradual refrigeration, has been preserved here in Eastern North America and in the corresponding parts of Asia, but was lost to Europe. I need not recapitulate the evidence upon which this now generally accepted doctrine was founded; and to enumerate the plants which testify in its favour would amount to an enumeration of the greater part of the genera or subordinate groups of plants which distinguish our Atlantic flora from that of Europe. The evidence, in brief, is that the plants in question, or their moderately differentiated representatives, still co-exist in the flora of Eastern North America and that of the Chino-

Japanese region, the climates and conditions of which are very similar; and that the fossilised representatives of many of them have been brought to light in the late Tertiary deposits of the Arctic zone wherever explored. In mentioning some of the plants of this category I include the Magnolias, although there are no nearly identical species, but there is a seemingly identical Liriodendron in China, and the Schizandras and Illiciums are divided between the two floras; and I put into the list Menispermum, of which the only other species is Eastern Siberian, and is hardly distinguishable from ours. When you call to mind the series of wholly extra-European types which are identically or approximately represented in the Eastern North American and in the Eastern Asiatic temperate floras, such as Trautvetteria and Hydrastis in Ranunculaceæ; Caulophyllum, Diphylleia, Jeffersonia, and Podophyllum in Berberideæ; Brasenia and Nelumbium in Nymphæaceæ; Stylophorum in Papaveraceæ; Stuartia and Gordonia in Ternstromiaceæ; the equivalent species of Xanthoxylum, the equivalent and identical species of Vitis, and of the poisonous species of Rhus (one, if not both, of which you may meet with in every botanical excursion, and which it will be safer not to handle); the Horse-Chestnuts, here called Buckeyes; the Negundo, a peculiar offshoot of the Maple tribe: when you consider that almost every one of the peculiar Leguminous trees mentioned as characteristic of our flora is represented by a species in China or Manchuria or Japan, and so of some herbaceous Leguminosæ: when you remember that the peculiar small order of which Calycanthus is the principal type has its other representative in the same region; that the species of Philadelphus, of Hydrangea, of Itea, Astilbe, Hamamelis, Diervilla, Triosteum; Mitchella, which carpets the ground under evergreen woods; Chiogenes, creeping over the shaded bogs; Epigæa, choicest woodland flower of early spring; Elliottia; Shortia (the curious history of which I need not rehearse); Styrax of cognate species; Nyssa, the Asiatic representatives of which affect a warmer region; Gelsemium, which, under the name of Jessamine, is the vernal pride of the Southern Atlantic States: Pyrularia and Buckleya, peculiar Santalaceous shrubs; Sassafras and Benzoins of the Laurel family; Planera and Maclura; Pachysandra of the Box tribe; the great development of the Juglandaceæ (of which the sole representative in Europe probably was brought by man into South-Eastern Europe in prehistoric times); our Hemlock-Spruces, Arbor-Vitæ, Chamæcyparis, Taxodium, and Torreya, with their East Asian counterparts, the Roxburghiaceæ, represented by Croomia—and I might much further extend and particularise the enumeration—you will have enough to make it clear that the peculiarities of the one flora are the peculiarities of the other, and that the two are in striking contrast with the flora of Europe.

(*To be continued.*)

SOCIETIES AND ACADEMIES

London

Linnean Society, December 18, 1884.—Sir John Lubbock, Bart., F.R.S., President, in the chair.—The following gentlemen were elected Fellows of the Society:—Liet.-Col. W. R. Lewis, and Messrs. T. B. Blow, H. G. Greenish, A. G. Howard, L. de Niceville, C. B. Plowright, and F. Shrivell.—Mr. H. Ling Roth showed roots of sugar-cane grown in Queensland; the plant appearing to him to possess two sorts, viz. ordinary matted fibrous roots and others of a special kind.—Mr. E. Alf. Heath exhibited a wild cat found dead in a trap in Ben-Armin Deer Forest, Sutherlandshire, where they are still frequently met with.—Mr. W. H. Beeby called attention to examples of burreed (*Sparganium*) obtained at Albury Ponds, Surrey, the plant being quite distinct from the other British species; he proposed for it the name of *S. neglectum.*—In illustration of ornithological notes, Mr. Thos. E. Gunn showed an interesting series in varied plumage of the somewhat rare British bird, the blue-throated warbler. The examples in question were procured by Mr. G. E. Power at Cley, on the Norfolk coast, in September, 1884. Mr. Gunn also exhibited an immature female little bittern, shot at Broxbourne Bridge, Herts, on October 15 in the same year; as likewise a hybrid between a goldfinch and bullfinch, which possessed the marked characteristics of both parents.—Attention was drawn to Mr. R. Morton Middleton's examples of varieties of Indian corn (*Zea mays*, L.) from the United States, Natal, and the borders of the River Danube. The specimens showed marked differences from each other in size, colour, form, and in ornamentation of the seeds.—Mr. Thiselton Dyer exhibited life-size photographs of cones of two species of *Encephalartus* from South Africa, viz. *E. longifolius* and *E. latifrons*, neither hitherto figured in European books. He also showed tubers of *Ullucus tuberosus* from Venezuela, which, though esteemed as an esculent in South America, proved inedible when grown at Kew.—A paper was read by Mr. Henry O. Forbes, on contrivances for insuring self-fertilisation in some tropical orchids. The author described in detail the structural peculiarities of certain Orchidaceæ which had been made the subject of study by him under favourable circumstances. He arrives at the conclusion that a number of orchids are not fertilised by insects, but are so constructed as to enable them to fertilise themselves. This paper was illustrated by diagrams referring more particularly to such forms as *Phajus Blumei*, *Spathoglottis plicata*, *Arundina speciosa*, *Eria javensis*, and others.—Prof. St. G. Mivart read a paper on the cerebral convolutions of the Carnivora and Pinnipedia, and wherein were described for the first time in detail the brains of *Nandinia*, *Galidia*, *Cryptoprocta*, *Bassaricyon* (from a cast of the skull), *Mellivora*, *Galictis*, and *Grisonia*. The author, confirming the views of previous observers, gave additional reasons for a three-fold division of the Carnivora into Cynoidea, Æluroidea, and Arctoidea, though he remarked that amongst the Æluroids the section of Viverrina formed a very distinct group, judged by the cerebral characters. He specially called attention to the universal tendency amongst the Arctoidea to the definition of a distinct and conspicuous lozenge-shaped patch of brain substance defined by the crucial and precrucial sulci. This condition, which he found in no single non-arctoid Carnivora, he also found in the brain of *Otaria Gillespii*, and afterwards in *Phoca vitulina*, where it is very small and much hidden. This fact he adduced as an important argument in favour of the view that the Pinnipedia were evolved from some Arctoid, probably Ursine, form of land Carnivora.—Mr. F. O. Bower read a paper on apospory in ferns. His microscopical investigations on the growth of sporophore generation to the prothallus without the intervention of spores but confirms the statements of Mr. Chas. T. Druery on *Athyrium Filixfœmina*, var. *clarissima*, previously communicated to the Society. Mr. Bower, moreover, finds the case in point to hold good in certain other ferns, for example, *Polystichum angulare*, where there is the formation of an expansion of *undoubted prothalloid nature* bearing sexual organs by a process of purely vegetative outgrowth from the fern plant. That is, there is a transition from the sporophore generation to the oosphore by a vegetable growth, and without any connection either with spores or indeed with sporangia or sori. The author goes on to point out the bearing of these observations and cultures on the general life history of the fern, so far as the modifications of the genetic cycle are concerned; and he further compares this new phenomenon of "apospory" in ferns with similar cases in other plants, while insisting on the importance of the cases at issue.—A communication on the aërial and submerged leaves of *Ranunculus lingua*, L., was read by Mr. Freeman Roper. He shows from specimens obtained near Eastbourne that the two sets of leaves in question differ so materially from each other that they might not be suspected to belong to the same plant, the submerged being larger, broader, ovate or cordate, and possessing abundance of stomata.

Geological Society, December 14, 1884.—W. Carruthers, F.R.S., Vice-President, in the chair.—David Llewellin Evans was elected a Fellow of the Society.—The following communications were read:—On the south-western extension of the Clifton fault, by Prof. C. Lloyd Morgan, F.G.S., Assoc. R.S.M.—On the recent discovery of Pteraspidian fish in the Upper Silurian rocks of North America, by Prof. E. W. Claypole, B.A., B.Sc. Lond., F.G.S.—On some West-Indian phosphate deposits, by George Hughes, F.C.S. (Communicated by W. T. Blanford, LL.D., F.R.S., Sec.G.S.).—Notes on species of *Phyllopora* and *Thamniscus* from the Lower Silurian rocks near Welshpool, Wales, by George Robert Vine (Communicated by Prof. P. Martin Duncan, F.R.S., F.G.S.).

Victoria (Philosophical) Institute, January 5.—A paper on "The Religion of the Aboriginal Tribes of India," by Prof. Avery, was read. In it the author sketched the peculiarities of the beliefs of those tribes, so far as was known.

Sydney

Royal Society of New South Wales, November 5, 1884.—H. C. Russell, B.A., F.R.A.S., President, in the chair.—Five

new members were elected and 129 donations received. A paper was read, "Notes on some mineral localities in the northern districts of New South Wales," by D. A. Porter. The following extracts from a letter, dated from Queensland, October 8, to Prof. Liversidge, from Mr. Caldwell, were read:—"Ceratodus has interfered with Platypus. The Platypus eggs were hatched three weeks ago, and I should have been in New England by now, but Ceratodus is much more important. Platypus embryos are quite easy to get. I can't understand how they have not been got before. The fact tha the monotremes are oviparous is the end of the research for many. They don't understand that it is the fact of the egg having a lot of yelk that promises to yield valuable information. Here are some of the principal points in the development of Ceratodus as observed on the whole embryos. I have not attempted to make sections yet; you know what section-cutting is now-a-days. The egg measures about 2½ mm. diameter, and has the protoplasmic pole darker, as in Amphibia. This egg is surrounded by a strong, closely-investing gelatinous membrane about 3½ mm. thick. The segmentation is complete (Holoblastic). Part of the blastopore remains open, and persists as anus. The stages up to hatching closely resemble those of the newt, Amblystoma. After hatching, the larva goes into the mud. It lies on its side like Pleuronectidæ among Teleosteans, and the oldest stages I have reared still show no signs of external gills. The larval changes I expect will continue for many weeks, and I have two plans to save my waiting here, both of which I intend to put into execution at once. First, I shall leave an aquarium with a large number of the larvæ here on a station, where a friend has kindly promised to put a few of the fish in a bottle every day. Second, I shall bring a supply of eggs to Sydney, and attempt to rear them in my laboratory. I hope to get to Sydney in about a fortnight or three weeks time. I have more than thirty blacks with me now; they have found over 500 Echidna in the last six weeks."—Prof. Liversidge exhibited specimens of sapphires, zircons, the topaz and diamond from the old gold workings near Mittagong, and stated that flints occurred at these mines closely resembling those of the cretaceous formations at home.—Mr. C. S. Wilkinson exhibited specimens of chloride of silver from Silverton, native antimony in calcite, Lucknow, also dendritic gold and arsenical pyrites in massive serpentine.—Mr. Charles Moore announced the discovery of a new species of the giant Australian lily, between the Clarence and Richmond Rivers, and promised some notes upon it at the next meeting.

PARIS

Academy of Sciences, December 29, 1884.—M. Rolland, President, in the chair.—Note on the classification of the moles (genus *Talpa*, L.) of the old world, by M. Alph. Milne-Edwards.—Theorem regarding the complete algebraic polynomes; its application to the rule of Descartes' signs, by M. de Jonquières.—On the integers of total differentials, by M. H. Poincaré.—On the integers of total differentials, and on a class of algebraic surfaces, by M. E. Picard.—On a series analogous to that of Lagrange, by M. Amigues.—Some simple and closely related formulas for the equilibrious pressure of sandy masses or bodies without cohesion, by M. Flamant.—Rectification of the numerical results indicated in a previous communication for the calculation of compressed gas manometers, by M. E. H. Amagat. The rectifications here made are stated by the author in no way to affect his general conclusions.—On seleno-uria and the substances derived from it, by M. A. Verneuil.—On the solubility of the substances comprised in the oxalic series—

$$CO(OH)—(CH^2)^n—CO(OH),$$

by M. Friedel.—On the composition of the seed of the cotton-tree and on the abundance of alimentary substances contained in this grain, by M. Sacc. Writing from Cochabamba under the date of October 25, 1884, the author announces the discovery of a new alimentary substance presenting some most remarkable features in its composition. The accompanying analysis shows that this seed of the cotton-tree, of which several varieties are cultivated in Bolivia, is the richest of all known grains in nitrogenous substances. When milled, it yields the following results:—

Yellow meal	56·50 kilogrammes
Black bran	40·50 ,,
Waste	3·00 ,,
	100 ,,

The writer is convinced that this flour is destined to take an important place in human alimentation, and in the preparation of all kinds of pastes, where it may act as a substitute for milk.—Note on the history of the discovery of the action of the white globules of the blood in inflammatory complaints, by M. A. Horvath. This discovery, hitherto attributed to Cohnheim, is here assigned to Dutrochet, who, so far back as 1824, accurately described the migration of the sanguine globules and their passage into the organic tissues.—Note on the biological evolution of the genus Aphis, and of the allied genera in the family of the Aphidæ, by M. Lichtenstein.—On the discovery of the impression of an insect in the Silurian sandstones of Jurques, Calvados, by M. Ch. Brougniart. The traces are described of the wing of a blattina, to which the author gives the name of *Palæoblattina douvillei*, in honour of M. Douvillé of the Paris School ol Mines.—On a crystalliferous vitreous mass resembling obsidian, and evidently derived by igneous action from the schistose rocks of the Commentry coal-measures, by M. Stanislas Meunier.

STOCKHOLM

Royal Academy of Sciences, December 10, 1884.—Prof. Edlund communicated some observations made during the last years confirming his theory on the origin of the electricity of the air, and also of the origin of the aurora borealis and of thunderstorms.—Prof. Nordenskjöld presented a paper on kryokonite from the inland ice of Greenland by himself.—Prof. Ångström gave an account of a report by E. D. Norrman, civil engineer, concerning his observations on ship-building, &c., during a Continental tour undertaken with a grant given by the Academy from the funds of the Litterstedt donations.—Dr. Widman reported on his own researches on a new sort of indigo and on some new derivations of chinolin produced by him from kumminol. The Secretary, Prof. Lindhagen, presented the following papers:—On the passage of the light through isotropical substances, by Prof. Rubenson.—A method to separate chlorine and bromine quantitatively, by Dr. E. Berglund.—On Vortmann's method to determinate chlorine directly, and also the presence of bromine, by the same.—On the intermediate orbit of the comet of Faye in the vicinity of Jupiter in the year 1841, by Dr. Alexander Shdanow of Pulkowa.

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THURSDAY, JANUARY 15, 1885

THE EARTHQUAKES IN SPAIN

EVEN the most conservative believer in the stability of Mother Earth must by this time have had his faith sorely shaken. Year after year, and month after month, we receive tidings of more or less serious shakings, varying from slight movements, such as merely set bells ringing and disturb the crockery on kitchen-shelves, to such shocks as convulse wide districts and bring with them disaster to life and limb as well as destruction to property. As if these tangible proofs of insecurity were not enough, we have learnt further that what we have been in the habit of dignifying with the name of the "solid" earth is really in a state of perpetual tremor. The thud of falling rain-drops, the patter of birds' feet, the tread of cattle, the gambols of children, so affect the ground on which we walk that the vibrations which they cause in it can be made clearly audible by the microphone and visible by the galvanometer. The position of the sun in the sky, the rise and fall of the tides, the thermometrical and barometrical oscillations of the atmosphere, produce in the outer parts of the earth corresponding pulsations, which, though not always certainly referable to their originating source, are perfectly recognisable, and can be registered by sufficiently delicate instruments. So that, instead of being on the whole a motionless, inert mass, the land is, in its way, almost as restless as the sea.

Fortunately, we are not sensible of these daily and hourly vibrations. It is only from time to time, by the news of earthquake-shocks from different quarters of the globe, that our attention is vividly drawn to the subject, and we are made to realise how little right we have to count on the continued stability of our own district. The daily tidings from the south of Spain, coming after so many recent chronicles of earthquake disaster in Europe, cannot but recall our thoughts to this subject. When the peace and goodwill of Christmas-tide were once more brightening the close of the year all over Christendom, the inhabitants of a wide tract of Andalusia were suddenly thrown into consternation by a succession of powerful earthquakes. The district most severely visited lies in the province of Granada and Malaga, and forms a parallelogram measuring about 70 miles from east to west and about 35 from north to south. The eastern part of the affected district passes into the great range of the Sierra Nevada, of which the highest peaks rise between 11,000 and 12,000 feet above the sea. Westwards, this range throws off some minor spurs, particularly the Sierras Tejada and Alhama, which curve round towards the north-west. The chief mass of the Sierras consists of crystalline schists stretching east and west, and flanked with Tertiary strata, from beneath which various Jurassic and other Secondary rocks emerge. The area of maximum destruction appears to be among the Western Sierras, and on the ground to the south and north of them.

The greatest amount of damage has been done at Alhama, which is almost entirely ruined. This little town stands nearly on the junction of the Tertiary rocks with the schists that rise into the more rugged ground of the mountains. A little to the south-east Abunuelas has also suffered severely. From that central area the shocks seem to have lessened outwards, but to have been felt most along the northern and southern flanks of the Sierras. According to one account the shocks have indicated earth-waves from south to north, with return movements in the contrary direction. Not improbably the actual focus of disturbance lies along the axis of the Sierras Alhama and Tejada. But the shocks have been felt over a much wider area. They have extended along the line of the mountains at least as far as Gibraltar in the west, though they are not recorded as having been marked in an easterly direction. Northwards, the towns and villages lying nearest to the centre of commotion have suffered most—Antequera, Loja, Granada. But far beyond these districts, terror was occasioned to the people of Cordova, Cadiz, and Seville, and the first shock was felt even at Madrid. No sea-wave has been chronicled as having affected any part of the coast, whence we may reasonably conclude that the earthquakes have not originated under the sea.

The Spanish peninsula has long had an evil reputation for the frequency, destructiveness, and long continuance of its earthquakes. In the present case the shocks are said to have begun three days before Christmas; but the first destructive wave arose on Christmas day. Since that date there has been an almost daily continuance of shocks of varying intensity. Such was also the case in the summer of 1863 along the great range of Sierras from Malaga to Alicante, and still earlier, in 1849, the same district continued to vibrate for several months.

Unfortunately, no accurate registers have been kept of these earth-tremors. Observations on earthquake phenomena made after the event, though useful so far, are now recognised as altogether insufficient to enable us to solve the problems presented by this interesting, but difficult, branch of geological physics. The establishment of self-registering apparatus, which was temporarily assisted many years ago by the British Association in the case of the simple instruments set up at Comrie in Perthshire, and which, more perfectly developed in Italy, has recently been so well inaugurated in Japan by Profs. Milne and Ewing, is the only satisfactory method of accumulating the necessary data. Until facts thus chronicled have been patiently gathered for some years in regions widely separated from each other, alike in distance and in geological structure, seismology must be content to remain very much at a stand. Of course, speculation will be as rife as ever, but cautious men of science will probably withhold their judgment until they are in possession of data of a kind that has not yet been systematically observed and registered.

But even before these data are gathered for the region of Andalusia, we can hardly doubt that fundamentally the shocks so often felt there arise from the process of mountain-making. The vibrations are propagated along the Sierras, and are felt with most violence near their flanks. They are probably in some way connected with the movements of the terrestrial crust that first started and have successively upraised the long parallel lines of mountainous ridge that diversify the surface of the Spanish tableland. Among the questions

awaiting investigation is whether any perceptible effect on the height and form of a mountain chain can be detected after its flanks have been convulsed with earthquakes; whether its rocks have been more tilted or folded or fractured. Men are usually too overwhelmed by the losses to life and property to take heed of such matters as these, and it may seem almost cold-blooded to suggest them for practical consideration. In all mountain districts much subject to earthquakes, it would be desirable to have an accurate system of levelling carried out, so that after a time of disturbance the heights could be checked. It would also be useful to have numerous photographs of cliffs and other sections where the rocks are well exposed, and where, therefore, any change of inclination, even to a slight extent, could be ascertained and measured. In regions where, as in the Karst, the earthquakes probably arise from the giving way of the roofs of underground tunnels or caverns, likewise in volcanic districts, the precautions here suggested might be of little use. But in those tracts where mountain-making is probably still in progress, they might supply us with many suggestive facts.

There is one other feature in the present Andalusian earthquakes to which allusion should be made. It has often been asserted and often denied that the occurrence of earthquakes is connected with the state of the atmosphere at the time. There certainly seems no doubt that in Europe, at least, the crust of the earth is considerably more convulsed by earthquakes in winter than in summer. When the shock of December 25th struck terror into the provinces of Malaga and Granada, the barometer, which a fortnight before had been remarkably steady, was exceptionally low and variable. Mr. George Higgin, of Broadway Chambers, Westminster, sends us an extract from a letter received by him from one of his engineers at Albox, in the valley of the River Almanzora, province of Almeria, not far to the eastward of the scene of disturbance. The writer, who was still unaware that there had been any earthquake, states that after December 19th a severe gale sprang up, lasting four days; the barometer varied from 29·28 on December 19th to 28·52 on the 27th, and continued to oscillate to such an extent that no trustworthy levellings could be made with it. A correspondent of the *Times*, writing on Sunday last, also mentions the low state of the barometer, and that the severest and greatest number of shocks continues to be felt from 5 p.m. till 5 a.m., and that since the outset, at intervals of about a week, the movement has shown a recrudescence with each return.

There has been also the usual chronicle of secondary effects from the earthquake shocks. Landslips have occurred, with the consequent disturbance of drainage. In one place a village has slid northwards about sixty feet, leaving a deep semicircular crevasse where it previously stood. The displaced ground has intercepted the course of an adjacent stream, so that a lake is forming behind the obstruction. At Periana a mass of rock and earth, disengaged from the slopes above, is said to have demolished a church and 750 houses. Among the numerous sulphur-springs of the region there has been considerable disturbance. Some of these sources, as has often been observed at Vesuvius and elsewhere, disappeared after the first shock, but in a day or two afterwards began to flow again at a higher temperature than before.

THE STABILITY OF SHIPS

A Treatise on the Stability of Ships. By Sir E. J. Reed, K.C.B., F.R.S., M.P. (London: C. Griffin and Co., 1885.)

THE stability of ships is a subject that has attracted considerable attention of late. Many disasters have happened to ships through insufficient stability, and have caused scientific men as well as practical naval architects to apply themselves to a renewed and close investigation of the subject. The result is that the ideas which till late prevailed respecting it are seen to be often superficial and incomplete, and in some cases not entirely free from error.

Sir Edward Reed has done good service in bringing out a treatise upon stability which presents the matter in a fresh, readable, and instructive form. Singularly enough this is the only work in the English language which attempts to deal exhaustively with it. Notwithstanding the magnitude and complexity of the subject, and its vast importance to all who are responsible for the wise design and safe management of ships, its treatment has previously been of a very restricted and imperfect character. The student of naval science has required to consult works which range over the wide field of naval architecture, and numerous papers that lie entombed in the published proceedings of learned societies, in order to acquire anything approaching a comprehensive knowledge of the problem of stability. Sir Edward Reed has brought together and placed into relation to each other the investigations made at various times by eminent men of the science of the subject, and the practical developments which have resulted therefrom. Among these are included the researches of French mathematicians and naval constructors, which have hitherto been but little known in this country.

The statement that a floating body, such as a ship, when laden so as to float at a given draught of water may assume any position—upright, inclined, or upside down—or it may when floating upright and in equilibrium be capsized with ease or with difficulty, according to the character or degree of the stability it may possess is the veriest scientific truism. Many may suppose it to be unnecessary, in this shipbuilding country, to make so self-evident an observation. Yet trite and obvious as it may appear when put into this form, it has been strangely, almost culpably, ignored by many who are responsible for the safety of ships. Very few exact investigations of the stability of individual ships have been made till quite recently; and even those that were attempted have frequently been imperfect and inconclusive.

The correct principles upon which the stability of ships depends were not demonstrated till the middle of the last century. Bouguer explained the properties of the metacentre in 1746, and gave a formula by which its position may be calculated. He also showed how the initial stiffness, and height of centre of gravity, of a ship may be determined by a practical experiment; this being the method of inclining vessels which is at length becoming usual in this country. Bouguer's investigations were followed up and extended by D. Bernouilli and Euler; and it was shown how the righting moments at large angles of inclination from the upright may be determined.

Atwood brought forward the subject clearly and forcibly

and at considerable length, in two papers read before the Royal Society in 1796 and 1798. He laid down the fundamental formula by which the length of the arm of the righting or upsetting couple may be determined for any angle of inclination of a ship; and he showed how the several terms contained in it may be calculated. Two of these terms, viz. the volumes of the wedges of immersion and emersion, and the positions of their centres of gravity, involved very lengthy and complicated calculations. The tediousness and complexity of stability investigations have been chiefly caused by the difficulties connected with finding by actual measurement and calculation the solid contents of these wedges and the positions of their centre of gravity.

Let Fig. 1 represent the transverse section of a ship, of which W L is the line in which the plane of flotation, when the ship is upright, is cut by the plane of the paper; the centre of gravity of the whole ship being at G. Let B similarly represent the centre of gravity of the volume of the ship's displacement, or centre of buoyancy, as it is commonly called. Now, suppose the ship to be inclined a few degrees by some external force that acts horizontally, and therefore does not alter the displacement; and let

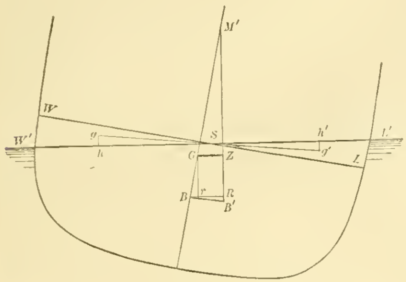


Fig. 1.

W' L' represent the new water-line. The effect of the inclination has obviously been to lift out of the water a wedge-shaped body, of which W S W' is the section, and to submerge on the opposite side of the ship another somewhat similar wedge-shaped body, of which the section is L S L'. These wedges are known as the wedges of immersion and emersion respectively. They are each bounded on the outside by the outside form of the ship, and will therefore usually differ in external form; but they must be precisely equal in volume, or otherwise the whole displacement of the ship could not remain unaltered.

The inclination of the ship through the angle W S W' has changed the position of the centre of buoyancy B to B'; and G Z is the length of the perpendicular let fall from G, the centre of gravity, upon the vertical B' M, through B'. G Z is the arm of the couple at the ends of which the weight of the ship and the upward pressure of the water act; and it is commonly called the righting arm. Atwood's fundamental formula for determining the length of the righting arm is—

$$GZ = v \times hh'/V - BG \sin \theta,$$

v being the volume of either of the wedges W S W', L' S L; $h\,h'$ the distance, measured parallel to W' L', between g and g', the centres of gravity of these wedges; V the volume of the ship's displacement; and θ the angle of inclination W S W'.

It is obvious that the labour of calculating the volumes and positions of centres of gravity of such irregularly shaped bodies as the wedges of immersion and emersion must be very great. The labour and difficulty are further increased by the necessity of drawing the inclined water lines, such as W' L', in positions which give equal volumes for these wedges. The point S, where the inclined water-line intersects the upright water-line, thus requires to be determined separately for each angle of inclination. Atwood's manner of approximating to the volumes and moments of these wedges was simplified by Mr. S. Read. The method which has commonly been adopted in recent years is, however, one brought forward at the Institution of Naval Architects, by Mr. F. K. Barnes, in 1861.

The old systems of stability calculation, even as modified by Mr. Barnes, were so excessively laborious and complex, that very few attempts were ever made to apply them to ships. The initial stiffness, as determined by the metacentric height, was practically the only element of stability that was investigated. It appears that, prior to 1867, no calculations were made which showed how the stability of a ship became affected by inclining her till the water-line came up over the deck, or at what angle the stability vanished. This was done for the first time at the Admiralty in 1867 by Mr. William John, under the direction of the author of the present work. The results of these investigations were published by Sir E. J. Reed in an interesting and instructive paper upon "The Stability of Monitors under Canvas," read before the Institution of Naval Architects in 1868. Curves are appended to this paper which show how the righting moments vary at successive angles of inclination, and the point at which they vanish. This paper proved conclusively how great are the dangers that have to be guarded against in ships of low freeboard and with high centres of gravity.

The extended application of stability calculations to cases involving greater irregularities in the volumes of the wedges of immersion and emersion than are contemplated by Atwood—such, for instance, as are caused by deck edges becoming immersed, or portions of deck erections becoming included in the volumes of the immersed wedges—created a demand for still more systematic and simple modes of calculation. This was supplied by Messrs. White and John in a paper read before the Institution of Naval Architects in 1871.

Down to the time of the *Daphne* disaster, which occurred in July, 1883, stability calculations made no further progress of importance in this country. At the Admiralty, and in some of our mercantile shipyards, the processes above described were gone through in cases where full knowledge of a ship's stability was considered requisite. Such calculations often took about a month to complete; and the results obtained were usually limited to a knowledge of how a ship's righting moment varied with angle of inclination at one or more chosen draughts of water. Even this was not considered essential when very light draughts of water were being dealt with.

The evidence given at the *Daphne* inquiry, and the

report of the Government Commissioner, Sir E. J. Reed, directed attention to imperfections in this department of shipbuilding practice, and furnished a powerful stimulus to renewed inquiry. Valuable results were speedily forthcoming in the shape of more complete and general expositions of the theory of stability than had previously been given: and in a great simplification, which at the same time included an extension, of the system of calculation. One of the most useful portions of the present work is that which describes the improvements thus made in the theory and practice of the subject.

The modern improvement of the theory is shown by Sir E. J. Reed to be in the direction of considering the variation of stability with draught of water, and the amount of stability a ship will possess at light draughts. The *Daphne* inquiry showed that the danger of instability which is sometimes to be found associated with light draught of water was frequently lost sight of because of a prevailing belief that, so long as a vessel has a high side out of water, and any initial stiffness, she will have a large range of stability. This point is clearly and fully dealt with by Sir E. J. Reed in his present work; and he states a general proposition which underlies it, and which was first enunciated by Prof. Elgar in the *Times* of September 1, 1883. It is that, if any homogeneous body which is symmetrical about the three principal axes at its centre of gravity be of such density as to float in equilibrium with its lowest point at a depth x below the water, then if the density be altered so as to make it float with its highest point at a height x above the water, the righting moments will be the same in both cases at equal angles of inclination, and, consequently, the range of stability and complete curves of righting moments will be the same. Sir E. J. Reed also gives copious extracts and diagrams from a paper read by Prof. Elgar before the Royal Society in March last, in which the variation of righting moment with draught of water is shown not only for symmetrical bodies, but also for floating bodies of irregular form and for an actual ship. These investigations indicate that the effect of lightness of draught upon stability may be as prejudicial, or even more so, than that due to low freeboard.

Sir Edward Reed deals very fully with the recent practical developments of the subject, and with the improved systems of calculation that have been devised. These have for their primary object the direct construction of curves showing the variation of righting arm with draught of water at fixed angles of inclination. The wedges of immersion and emersion are no longer dealt with in the stability calculations. Atwood's formula involving the volumes and moments of the wedges of immersion and emersion is discarded, and the following one is employed (see Fig. 1) $GZ = BR - BG \sin\theta$. BR is computed by calculating the under-water volume at the inclined water-line W′L′, and its statical moment. These calculations can be made very quickly and easily with the aid of Amsler's mechanical integrator: and the complication involved by dealing with the two separate wedges, and equating their volumes, may thus be avoided. Sir Edward Reed describes the methods put forward by Mr. W. Denny—who appears to have been the first to suggest this important step—Mr. Macfarlane Gray, Mr. Benjamin, and others.

It is singular that while naval architects in this country were thus working out for themselves those extensions of the difficult problem of stability which modern requirements have demanded with continuously increasing force, the French appear to have been long in possession of a complete and admirable system. So long ago as 1863 M. G. Dargnies was making calculations of stability at Marseilles for numerous angles of inclination, and for four or five draughts of water; and in 1864 M. Reech put forward a most ingenious and perfect method for bringing all the probable stability conditions of a ship into full view and under calculation. The advantages of this method were so striking that it was not long in becoming practically adopted in France, and, in 1870, M. Risbec prepared a paper upon it, together with a calculation form for facilitating its application. Sir Edward Reed gives a concise and clear exposition of the systems of MM. Dargnies, Reech, and Risbec, together with an example of M. Risbec's calculation form. The investigations of MM. Ferranty and Daymard are also described in detail. The latter are probably better known in this country than any of the others referred to, in consequence of a paper which M. Daymard read upon the subject before the Institution of Naval Architects in April last.

There is much in this large and important work to which it is hardly possible to refer, still less attempt an adequate discussion of, within the limits of a short review. We shall return to the subject in a future number. In the meantime, all who are interested in this branch of science, and its bearing upon the construction and safe treatment of ships, will do well to refer to the book itself for full and precise information upon the various aspects of the theory of stability and its practical applications. Fundamental principles are clearly described and illustrated, and may be readily understood by persons possessing an elementary knowledge of mathematics. On the other hand, the elegant and extensive investigations of Dupin, Leclert, Guyon, Moseley, Woolley, and others furnish profitable subjects of study for the most advanced of mathematicians.

(To be continued.)

OUR BOOK SHELF

Natural History Sketches among the Carnivora, Wild and Domesticated; with Observations on their Habits and Mental Faculties. By Arthur Nicols, F.G.S., &c. (London: L. Upcott Gill, 1885.)

THIS little volume of some 250 pages is full of interest: treating somewhat of lions and tigers, it has a pleasant portion of a chapter about cats, but the bulk of the volume is devoted to man's faithful friend, the dog. Of the several excellent illustrations we would especially mention the life-like one of a lioness watching its prey, from a drawing by Mr. J. T. Nettleship, which is very full of vigour and muscular force, one of the black-maned African lion, by Mr. C. E. Brittain, and one of Chang, Mr. G. B. Du Maurier's Grand St. Bernard, by Mr. T. W. Wood. As one of the interesting subjects touched on by Mr. Nicols, we may allude to that treating of the sense of smell in dogs. He alludes to this in connection with the habit possessed by some dogs of rolling in decaying animal, or even vegetable, substances. On one occasion Mr. Nicols noticed his retriever vigorously anointing himself by rolling about in a clump of living fungi which emitted a particularly evil smell. This is thought to be an inherited habit, or, as Mr. H. Dalziel writes, "Taste and smell being

closely allied senses, this rolling causes pleasurable sensations from association with the glorious feasts enjoyed on battle-fields and on putrid carcases of animals," and from this the author hints that possibly, and even probably, when grouse or venison come to our tables in a state of actual decomposition, this represents a taste acquired years ago by the conditions of a primitive life, and is not to be distinguished from a habit which brings upon our domestic dogs the severest reprobation and prompt chastisement. It seems a subject, however unsavoury, well worthy of being investigated, and doubtless many facts bearing on it in reference to uncivilised people are yet to be narrated. Once we call to mind a small knot of semi-civilised Africans captured in a slave dhow off Mosambique that we interrupted at a midnight feast; they were partly eating and partly smelling a mass of half-putrid fish, which seemed, to say the least, to make them uproarious. They had been under civilisation of a sort since their infant days, but seemed full of hereditary instincts. Mr. Nicols's work is full of his own careful observations, and forms a most pleasant addition to our knowledge of the habits and mental faculties of the Carnivora.

Entwickelung der Ortschaften im Thüringerwald. Von Dr. F. Regel. *Petermann's Mitteilungen*, Ergänzungsheft No. 76. (Gotha: Perthes, 1885.)

THIS is a very complete account of the origin and development of the towns and villages in the region known as "the Thuringian Forest," with a special chapter on the geology, topography, and climatology of the district, and a valuable map. The "Thuringian Forest" extends from Eisenach, on the north-west, to Schleusingen, on the south-east, and covers an area of about 1200 kilometres, with a population of 143,986. The mountains of this region are mainly composed of granite, gneiss, palæozoic strata, and porphyry. About a third of the district is still covered with wood. Formerly there was a great variety of trees, comprising the pine, oak, beech, birch, elder, maple, aspen, and willow; but now the forests consist almost entirely of pines, with a few beech woods between Friederichroda and the mediæval walled town of Schmalkalden. The average temperature is somewhat lower than that of the whole of Germany. In the higher villages neither wheat nor the finer kinds of fruit will thrive, and there is frost during from ten to eleven months in the year. The climate, however, is very healthy, and the beauty of the scenery and purity of the mountain streams attract many visitors during the summer months. The highest, and one of the most popular, of these summer resorts is Oberhof, a village at the top of the pass over the Schützenberg, of which the earliest record is in the year 1267. Only oats and potatoes can be grown here (2541 feet above the sea-level), and even the house-sparrow cannot be acclimatised. Eisenach, the capital of the district, is chiefly known on account of the confinement of Luther in the neighbouring castle of Wartburg, which was erected to guard the Thuringian frontier on the west in the years 1067 to 1070. This fortress was close to the junction of two important roads from Erfurt and Mühlhausen, and, as usual in such cases, a town rapidly grew up at the foot of the hill on which the fortress was built. Eisenach now has 13,000 inhabitants, with three churches and several factories. Other towns and villages not so favourably situated owed their development to the neighbourhood of mines, healing waters, &c. Ruhla, a flourishing town of 4500 inhabitants, was celebrated in the first half of the sixteenth century for its steel manufactures, but foreign competition and heavy taxes nearly ruined the place, and in 1748 the population had considerably diminished. The enterprising spirit of the inhabitants, however, was soon drawn into a new channel by the discovery of mineral waters and the introduction of the manufacture of carved amber and pipe-bowls of imitation meerschaum, an industry which has attained considerable proportions. A somewhat similar history is that of the manufacturing town of Ilmenau, which is first mentioned in the chronicles of the fourteenth century. It flourished as an important centre of the copper-mining district of the Ilm up to the year 1739, when the mines were flooded by an inundation. In 1752 the town was burnt to the ground, and, though partly rebuilt, it shared in the general distress caused by the seven years' war, and did not revive until the beginning of the present century, when the manufacture of glass, porcelain, and toys was introduced. In 1838 the establishment of a hydropathic institution afforded a further stimulus to the trade of Ilmenau, and the population has increased from 1972 in 1809 to 4593 in 1880. On these and other places of less note in the Thuringian Forest Dr. Regel's work affords abundant information, though it is somewhat overcharged with notes and references which serve rather to display the extent of the author's reading than to illustrate his text.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

River Thames—Abnormal High Tides

REVERTING to my letter of December 19, 1883, inserted in NATURE for January 10, 1884, I append an abstract of salient exceptional tides of last year similar to that accompanying my former letter, from which it will be seen that the maximum elevation of tide is eleven inches less than in 1883, and the excess over the computed rise is also less by seventeen inches than in 1883—in each year resultant on north-north-west gales. Both year's results may be said to be analogous, and each showing how sensitive is the high-water level and how easily it is affected and raised by a change from south and west to northerly winds.

High Waters referred to "Trinity"

1884	Computed	Observed	Difference	Wind
	′ ″	′ ″	′ ″	
Jan. 12 p.m.	0 3 above	1 6 above	1 3	W.N.W.[1]
,, 24 a.m.	3 0 below	0 6 below	2 6	W.N.W.[1]
,, 31 p.m.	0 10 above	2 0 above	1 2	W.S.W.
Feb. 1 ,,	0 10 ,,	2 0 ,,	1 2	W.S.W.
,, 14 ,,	0 8 ,,	2 0 ,,	1 4	W.N.W.[2]
,, 25 ,,	0 10 below	0 3 ,,	1 1	W.N.W.[2]
Mar. 11 ,,	0 2 above	1 9 ,,	1 7	N.[2]
,, 12 ,,	0 6 ,,	2 5 ,,	1 11	W.S.W.[3]
,, 26 ,,	0 2 ,,	1 3 ,,	1 1	E.N.E.
April 22 ,,	2 1 below	0 6 ,,	1 7	E.N.E.[4]
June 7 ,,	1 0 ,,	0 3 ,,	1 3	N.N.E.
,, 25 ,,	1 1 above	2 3 ,,	1 2	N.N.W.
July 8 ,,	0 10 below	0 3 ,,	1 1	S.S.E.
,, 9 ,,	0 6 ,,	0 6 ,,	1 0	S.S.E.
,, 25 ,,	1 0 above	2 0 ,,	1 0	N.N.W.[5]
Aug. 16 a.m.	2 3 below	1 0 below	1 3	S.
,, 25 p.m.	0 3 above	1 4 above	1 1	N.
Sept. 2 ,,	2 7 below	1 6 below	1 1	W.S.W.
,, 5 ,,	"Trinity"	1 6 above	1 6	W.N.W.[6]
,, 22 ,,	0 7 above	1 9 ,,	1 2	W.
Nov. 6 ,,	1 4 ,,	2 9 ,,	1 5	E.N.E.[7]
Dec. 20 ,,	0 5 below	1 9 ,,	2 2	N.N.W.[8]
,, 22 ,,	0 9 ,,	0 6 ,,	1 3	N.

J. B. REDMAN

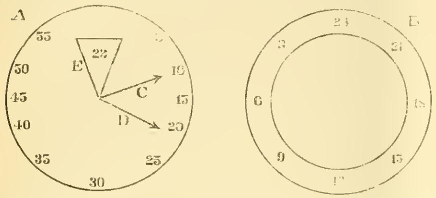
6, Queen Anne's Gate, Westminster, S.W., January 5

Our Future Clocks and Watches

IT is to be hoped that the absurd dial of which you give a drawing will not come into general use. Why not adopt the convenient shape which for more than a century has been in use

[1] Wind Influence. [2] Northerly Influence.
[3] Still felt. [4] Wind blowing right up the estuary.
[5] Sewage up to Westminster with this tide. [6] N.N.W. day before.
[7] Maximum tide of year; W.N.W. gale day before.
[8] Gale and remarkable fall of barometer = 29° 10′.

on the continent for some jewelled watches?:—A is the shape of the visible dial; C is the minute hand; D is the second-hand (sometimes dispensed with); E is an aperture in the dial through which is seen the hour, brought there by the hourly revolution of the wheel B; B is a wheel (and in watches of the size of a



shilling a series of wheels or a metallic band rolling round a drum of special construction for those tiny watches) immediately under the dial, set in motion once every hour, and bringing the corresponding numbers under the aperture E. CHATEL

Jersey, January 5

THE COAL QUESTION

IT is generally admitted that the amount of coal existing below Great Britain at such depths that it can be worked is limited, that large quantities of coal are annually used, and that even the partial exhaustion of the fields, accompanied, as it must be, by a rise in price, would seriously affect almost all our manufactures, and greatly endanger our commercial supremacy. But if we attempt to go further, and say how long our supply of coal will last, we meet with very different estimates. Nearly a hundred years ago the question was discussed by Mr. John Williams, and though the insufficiency of the data did not allow him to give a definite answer, he at least showed the vital importance of the subject.

In 1861, Mr. Hull, by taking into account the area of all our coal-fields and the thickness of the workable seams, calculated that the total available coal in Great Britain was 79,843,000,000 tons; this result was shown by a second calculation to be slightly too low. Further, he assumed that the output of coal, which was then 86,000,000 tons, could not rise much above 100,000,000, and therefore that our supply was sufficient for eight centuries.

Four years later Prof. Stanley Jevons, in an admirable essay on "The Coal Question," accepted the more important of Mr. Hull's data, but showed that they would bear a very different interpretation, and that, instead of the eight centuries spoken of by Mr. Hull, "rather more than a century of our present progress would exhaust our mines to the depth of 4000 feet." He then shows that the absolute physical exhaustion of the fields is improbable, but that before the twentieth century is far advanced the output of coal will probably be checked by a rise in price so considerable that England will be unable to compete in manufactures with other nations still enjoying the profusion of coal to which her present commercial prosperity is so greatly due. These theories and results were reviewed and strengthened by Prof. Marshall in 1878 ("Coal, its History and Uses"), with the aid of more recent statistics; and the present paper is intended to give a short and simple account of the present state of the question from the physical side, with the omission of the more difficult and dubious arguments which may be drawn from Political Economy.

The arguments of Prof. Stanley Jevons were so conclusive, and his results so alarming, that a Royal Commission, of which the Duke of Argyll was chairman, was appointed, in 1866, to investigate the probable quantity of coal contained in the coal-fields of Great Britain. In 1871 the Commission reported that the coal-fields already in use still contained 90,207,000,000 tons of coal, and that concealed coal-fields as yet unopened, near Doncaster, Birmingham, and elsewhere, probably contained 56,273,000,000 tons more, or that, in all, 146,480,000,000 tons of coal were available. Since that time about 1,780,000,000 tons of coal have been raised, leaving as the available supply in 1884 about 144,700,000,000 tons. Subsequent investigations show that this estimate is probably considerably too high.

These results were intended to include all beds a foot and upwards in thickness lying within 4000 feet of the surface, though it was rendered probable at the same time that the amount of coal below 4000 feet is not very large. The reason for excluding all beds less than a foot thick is that, at present prices, it is found unprofitable to work them, and hence, except in a few special cases, they are left untouched, though rendered worthless for the future from the disturbance of the strata occasioned by working the other beds.

Though we may assign no limit below which it is impossible to work, the cost of mining increases so rapidly with increased depth that the price of coal must rise very seriously before even the 4000-foot limit can be reached. This increase of cost depends upon various causes. The mere sinking of three shafts like those of Murton, which are said to have cost 300,000*l.*, burdens the undertaking, if it last fifty years, with an interest and sinking fund at 4 per cent. amounting to 13,965*l.* per annum. More powerful winding and pumping engines must be employed, and from the great expense of shaft-sinking, larger areas must be worked from one shaft, necessitating extra expense in underground haulage, ventilation, and supports. Further, each actual coal-hewer requires a larger amount of assistance to secure his safety and to remove his winnings in a deep pit. A coal-hewer working at an open seam on the surface of the ground would only require one labourer to wheel away the coal, while in a deep mine each hewer requires about three men to attend to the removal of the coal, the pumping, and ventilation.

The high temperature of the rock at great depths is also an important factor in the expense of deep mining. In England there is found to be a uniform temperature of 50° F. about 50 feet below the surface; but this temperature is found to increase 1° F. for every 60 feet descended, so that at 4000 feet the temperature of the rock will be about 116° F. And though this temperature is not sufficiently high to prevent working, and might be lowered a few degrees by ventilation, it will cause a considerable increase in the expense, both from the lassitude and extra pay of the men, and the larger amount of air required, which even now at Hetton amounts to 450,000 cubic feet per minute.

These difficulties account for the manifest reluctance to sink deep pits, for the high price charged for the coal from them, and for the fact that the 4000-foot limit has not yet been approached. In 1846 the Messrs. Pemberton's pit at Monkwearmouth reached 1720 feet; in 1858 the Astley pit at Dukinfield reached 2100 feet; in 1869 the Rosebridge pit at Wigan reached 2448 feet; in 1881 the Ashton Moss pit near Manchester reached 2688 feet; and though the Lambert pit in Belgium has been worked at 3490 feet, the circumstances were exceptional, and it is certain that the commercial success of such a pit in England would necessitate a price of coal far higher than it at present is.

The early estimates of the annual output of coal are so unreliable that it is useless to go back further than 1854, when "Mineral Statistics" were first carefully collected by Mr. Robert Hunt, and even in these returns the amounts for the first few years are possibly as much as three per cent. too low, from the difficulties of overcoming the fears of the coal-owners as to the uses which might be made of them. These returns have been collected and arranged by Mr. Meade, in his "Coal and Iron Industries

of the United Kingdom," from which Columns I. and V. of the following table have been for the most part taken.

Since the amounts of coal used are very large, and great accuracy cannot be expected in inquiries of this nature, it is convenient to take as the unit of our calculations 1,000,000 tons of coal instead of our ordinary unit, the ton. This unit may be expressed in several different ways: a cubic yard of anthracite weighs about 2700 lbs., and of bituminous coal from 2090 to 2400 lbs., hence on an average a cubic yard of coal weighs a ton; and our unit of 1,000,000 tons is a cubical block of coal 100 yards each way, or a bed of coal a mile square and a foot thick. Column I. in the following table gives the annual output of coal since 1854, and the total output during the thirty years, which amounts to 3,245,100,000 tons.

Amount of Coal in Million Tons

Year	I. Won	II. Calculated $64\cdot7+3(n-1)$	III. Calculated $62\cdot85 \times 1\cdot035^{n-1}$	IV. Calculated $65\cdot5 \times 1\cdot0325^{n-1}$	V. Exported
1854	64·7	64·7	62·9	65·5	3·4
1855	64·5	67·7	65·0	67·6	5·1
1856	66·6	70·7	67·3	69·8	5·9
1857	65·4	73·7	69·7	72·1	6·8
1858	65·0	76·7	72·1	74·4	6·6
1859	72·0	79·7	74·6	76·9	7·1
1860	84·0	82·7	77·3	79·4	7·4
1861	86·0	85·7	80·0	81·9	7·9
1862	81·6	88·7	82·8	84·6	8·4
1863	86·3	91·7	85·7	87·4	8·3
1864	92·8	94·7	88·7	90·2	8·9
1865	98·2	97·7	91·8	93·1	9·3
1866	101·6	100·7	95·0	96·1	10·1
1867	104·5	103·7	98·3	99·3	10·6
1868	103·1	106·7	101·7	102·5	11·0
1869	107·4	109·7	105·3	105·8	10·7
1870	110·4	112·7	109·0	109·3	11·7
1871	117·4	115·7	112·8	112·8	12·7
1872	123·5	118·7	116·8	116·5	13·2
1873	127·0	121·7	120·8	120·3	12·6
1874	125·1	124·7	125·1	124·2	13·9
1875	131·9	127·7	129·4	128·2	14·5
1876	133·3	130·7	134·0	132·4	16·3
1877	134·6	133·7	138·6	136·7	15·4
1878	132·6	136·7	143·5	141·1	15·5
1879	134·0	139·7	148·5	145·7	16·4
1880	147·0	142·7	153·7	150·4	18·7
1881	154·2	145·7	159·1	155·3	19·6
1882	156·6	148·7	164·7	160·4	20·9
1883	163·8	151·7	170·4	165·6	22·8
Totals	3245·1	3246	3245·1	3251	351·7

A few comparisons may enable the mind to grasp the real meaning of these enormous figures. It was calculated by Sir Henry Bessemer that the output of coal, 154,000,000 of tons for the single year 1881, would suffice to build 55 Great Pyramids, or to rebuild the Great Wall of China, and to add a quarter to its length! In 1883 the output was 163,800,000 tons, which would form a column a mile square and nearly 164 feet high; or would build a wall from London to Edinburgh 400 miles long, and 45 feet 9 inches high and thick, or another round the world 24,000 miles long, and 5 feet 11 inches high and thick; or, if the Straits of Dover are 21 miles across and 600 feet deep, would make an embankment across them 22 yards wide: while the total output for the 30 years would build a round column 9 feet 4 inches in diameter, which would reach 240,000 miles high, the distance of the moon.

The numbers show considerable fluctuations—as might be expected from the variety of accidental circumstances, such as new inventions, the mean annual temperature, and the state of trade, which affect the amount of coal used—but, on the whole, a very rapid increase; the output for 1875 being double of that for 1854, and that for 1883 double of that for 1862.

If we assume that the increase in annual output would be constant were it not for accidental circumstances, we can represent the actual numbers, with fair accuracy, by an arithmetical series of which the first term is 64·7, and the last 151·7, the increase in annual output being 3, and the total amount 3246 (Column II.). Further it has been shown that the coal still available in 1884 is 144,700,000,000 tons, and we may assume that the output in 1884 will be at least as great as that in 1883, or 163,800,000 tons. Hence, if the output of coal continues to increase at the rate of 3,000,000 tons annually, our supply will last for 261 years, or will be exhausted about A.D. 2145.

But this calculation is open to several objections, and the numbers as shown by Prof. Stanley Jevons may bear a much more serious significance.

It is improbable that the annual difference should always remain the same, and in fact, in the calculated series (Column II.), while all the early terms are higher than the real outputs, the later terms are lower, showing that the difference itself probably increases. If we calculate the series backwards we have no output at all about 21 years before 1854, a result we cannot agree with, and for all years before 1833 a negative output, a result we cannot understand. Hence it is probable that the results may be better expressed by another kind of series.

Theory and experience show that the same causes always produce the same effects, unless fresh circumstances intervene to modify the effects produced. Thus the population of England, which was about 9,000,000 in 1801, became 18,000,000 in 1851, or doubled in 50 years; hence, if no new causes intervene, we should expect it to double again in the next 50 years, or to become 36,000,000 in 1901. This is usually expressed by saying that social statistics in general show uniform multiplication in uniform periods, or obey the compound-interest law, or form a geometrical series. As an example of this law let us examine a little more closely the population of England and Wales. The increase for each 10 years since 1801 is itself perpetually increasing, or the numbers must be expressed by a geometrical series of which the ratio is nearly 1·147, and not by an arithmetical series.

Year	1,000,000 Inhabitants	Increase in Ten Years	Calculated $8\cdot89 \times 1\cdot147^{(n-1)}$
1801	8·89		8·89
1811	10·16	1·27	10·20
1821	12·00	1·84	11·70
1831	13·90	1·90	13·42
1841	15·91	2·01	15·39
1851	17·93	2·02	17·65
1861	20·07	2·14	20·24
1871	22·71	2·64	23·22
1881	25·97	3·26	26·63
Sum	147·54		147·34

From the dependence of the numbers representing the annual output of coal upon the number of inhabitants, it might be expected that they also can be expressed by a geometrical series, and this has been shown by Prof. Stanley Jevons to be the case. According to his calculations the ratio of the series is about 1·035, or the rate of increase of the output is about $3\frac{1}{2}$ per cent per annum, and it may be assumed for the reason before given that the sum of all the outputs is likely to be more approximately correct than the single output for 1854. The annual outputs calculated from these data are given in Column III., and show a fair approximation to the actual numbers, though the first term is rather low, and the last six terms are nearly as much above the true results as those in the

arithmetical series were below them. In fact, either from a prolonged fluctuation in trade, or from the operation of the cause we are discussing, the outputs for the last six years have not increased so rapidly as the previous numbers would lead us to expect. The outputs for the years 1854-77 are very fairly expressed by a series of which the first term is 63·9 and the ratio 1·0355, but this series makes the last six terms far too high.

Again the ratio 1·03 gives 71 as the first term, and makes all the early terms considerably too high. In short, the fluctuating numbers in Column I. seem to be best expressed by a series of which the first term is 65·5 and the ratio 1·0325; the outputs calculated from these data are given in Column IV.

It is easy also to calculate backwards and obtain earlier terms in the same series, thus for 1840 an output of 43,000,000 tons is given, and for 1800 one of 11,700,000, instead of Mr. Hull's conjecture of 36,000,000 and 10,000,000 tons respectively. And taking the true output of 163,800,000 of tons in 1883 and the ratio 1·0325, we can calculate the probable output for any future year. Thus for 1901 we obtain 282,000,000 tons instead of 331,000,000 as calculated by Prof. Stanley Jevons. Further, a well-known formula gives the sum of any number of terms of the series, or we can calculate in how many years the amount of coal raised will be equal to any given amount, say to the 144,700,000,000 tons remaining in 1884. Making the calculation, we find that if the present rate of increase in the consumption of coal of $3\frac{1}{4}$ per cent. per annum continues, or, in other words, if our output of coal continues to double every 22 years, our total supply will be exhausted in 106 years from 1884, or about A.D. 1990.

Of course no one can suppose that our consumption will continue to increase until it comes to a sudden and final end, but only that within a comparatively short period our output of coal must reach a maximum, and then gradually diminish as it becomes more scarce and expensive.

These calculations, then, seem to force upon us one of four possible conclusions:—Some new source of energy may be found to supply the place of coal; a larger proportion of the energy contained in our coal may be utilised, so that an output as large as the present one may produce a much larger amount of useful work; coal may be imported from other countries to supply our deficiencies; or lastly, the commerce and manufactures of England may pass into a stationary or retrograde condition.

Coal is used directly as a source of heat in our domestic fireplaces, as a source of mechanical energy indirectly in our steam- gas- air- and electric-engines, and as a heating and reducing agent in our metallurgical furnaces. A pound of fairly good coal will heat about 13,000 lbs. of water through 1° F., and in an ordinary steam boiler about 8000 of these units of heat are utilised, which suffice to turn rather more than 7·3 lbs. of water at ordinary temperatures into steam. But the unit of heat is able to do work to the extent of raising 775·4 lbs. through one foot in opposition to gravity. Hence, by burning one pound of coal, rather over 10,000,000 foot-pounds of work may theoretically be obtained. A first-rate steam-engine does effective work to the extent of about one-ninth of the theoretical amount. Hence, in round numbers, a pound of coal will do 1,000,000 foot-pounds of work, or as much work as is done by 32 ordinary men in ascending the 202 feet to the top of the Monument. According to Péclet, a pound of average coal contains ·804 lb. carbon, ·0519 lb. hydrogen, and ·0787 lb. oxygen, and would therefore theoretically suffice to reduce $8\frac{1}{4}$ lbs. of hematite with formation of $5\frac{3}{4}$ lbs. of iron. Any complete substitute for coal must be able to perform each of these three duties of coal.

It seems improbable that any new source of energy on the large scale will be discovered, though possibly small engines may be driven by some form of explosive, and hence tides, winds, and waterfalls alone, have to be considered as substitutes for coal. According to Sir William Thomson, energy in the form of electricity might be conveyed for 300 miles through a copper rod with a loss of only 20 per cent. from such a waterfall as Niagara, and stored up in secondary batteries for distribution. It is only necessary, without going into details of expense, to point out that we have no monopoly of winds, tides, or torrents, such as we have had of coal, and in fact, were they the sources of energy, we should compete with our neighbours rather at a disadvantage.

The next point to consider is how far more economical methods of obtaining and using our coal may reduce the output. It has been already pointed out that, as with coal at its present price it is not commercially possible to work seams less than a foot thick, all such coal is wasted. Large quantities of coal also are more or less unavoidably wasted in the processes of cutting and carrying, and it seems as if any great reduction in this amount must be accompanied by a considerable rise in price.

The uses to which our coal is applied, may, for the purposes of this inquiry, be roughly grouped under four heads—mining and metallurgy; manufactures, and locomotion on land and sea; domestic uses, including the supplies of gas and water; and lastly, for export. Under the first three heads, no doubt, large saving is possible, but it is not likely to be begun except under the pressure of a scarcity of coal, when the high price of the coal will cause the introduction of more expensive and more efficient machinery.

By far the most important metallurgical operation is the production of iron, which may therefore be taken as an example of the others. In 1788, 7 tons of coal were used per ton of pig-iron produced, which sank to 5 tons about 1800. The introduction of the hot blast in 1829 caused a further drop to $3\frac{1}{2}$ tons in 1840; and that of regenerators in 1857 caused a further fall to $2\frac{1}{2}$ tons in 1875. But the increase in the quantity of iron manufactured renders the actual saving of coal very small. In 1881, 18,300,000 tons of coal were used in making 8,300,000 tons of pig-iron, and a nearly equal amount of coal was required to convert five-eighths of the pig into wrought iron and steel. So that, in all, the iron-works required 34,700,000 tons of coal.

Experience seems to show that, though our best steam-engines give an efficiency of one-ninth, and the efficiency of air- and gas-engines is even higher, except in special circumstances, it is commercially preferable to use less efficient engines; the saving of coal at present prices being more than compensated for by the higher cost of the better engine. It is possible, however, that in the future electric engines may be used of far greater efficiency than our present steam-engines. On the other hand, the high rates of speed now demanded both for passengers and goods necessitates the consumption of large quantities of coal. Thus on a level railway a ton of load requires a pull of about $16\frac{1}{2}$ lbs. to draw it at the rate of 29 miles per hour, while, if the rate be increased to 50 miles per hour, the pull is nearly 33 lbs. Hence the 13,500 locomotives in Great Britain will require much more coal to drag the same loads at the higher rate. Our merchant navy also is being rapidly converted from sailing into steam vessels; in the 14 years 1866-1879, the number of sailing vessels *decreased* 5600, while the steamers *increased* 2200; and the steamers engaged in the foreign trade used in 1881 5,200,000 tons of coals, in 1882 5,600,000, and in 1883 6,400,000.

The aggregation of people in towns requires the use of coal for the production of gas or electric lighting, frequently for the removal of sewage and refuse, and for the supply of water. Possibly the most wasteful use to which coal is applied is our common domestic fireplace. But it would require an enormous increase in the price of coal to induce the average Englishman to convert his genial,

wasteful, open fireplace into the dull, though economical Continental stove.

The trade in coal and coke, especially to France, Germany, Russia, and Sweden, has reached very considerable dimensions, and is, in fact, the fourth most important of our exports. In Column V. it will be noticed that the 3,400,000 tons exported in 1854 have become in 1883 22,800,000 tons, worth more than 8,000,000*l*., or in thirty years the export of coal has multiplied more than six times. Any considerable lessening in this amount would of course seriously affect the balance of our trade with other countries.

It seems hardly necessary to meet the objection that when our own stores are exhausted we may import coal from other countries. A few considerations will show the fallacy of such reasoning. The nearest stock of coal on which we can hope to draw is that in Canada and the United States. The former supply is plentiful, but much of it is badly situated for exportation. In the United States coal is found in Virginia, Utah, and the Western States, and the basin of the Mississippi and its tributaries contains coal-fields estimated to cover 200,000 square miles, and to contain about 38 times as much available coal as Great Britain. According to Mr. Hull, these fields could as easily supply an output of 2,704,000,000 tons as we can one of 90,000,000.

Putting aside the commercial difficulties dwelt on by Prof. Stanley Jevons in the way of converting a large export trade in our staple raw material into an immensely larger import trade, the fact that even now the rivalry with the ingenuity and perseverance of the American manufacturers, aided though we are by their high tariff, demands all our skill and energy, and the almost universal law that manufactures cluster round the source of power, the physical difficulties of such a traffic would be enormous. Suppose a steamer similar to the *Faraday* capable of carrying 6000 tons, and so swift as to be capable of making 13 trips from America in the year; she would annually bring 78,000 tons of coal, or it would require a fleet of 2100 such ships to supply even our present requirements. And if the coal could be supplied to our shipping in American ports at 10*s*. a ton, we should have annually to pay America 81,900,000*l*., an amount not far below our present national income. The further cost of carriage across the Atlantic and delivery in English towns, must raise the price of coal to many times what we at present pay.

We are brought, then, face to face with the last of the four above-mentioned possibilities. Before very many years are past we must expect that the scarcity of coal in England will cause a considerable rise in price, which will directly affect all such branches of trade and manufactures as depend upon coal, and indirectly all other branches.

What this means in the former case will be evident from a brief consideration of the uses to which coal is applied, a few instances of which have already been given. Let us take one instance of the latter class—the importation of food-stuffs. The increase in the population of England per square mile, which was 37 in 1066, 75 in 1528, 140 in 1780, 241 in 1831, and 443 in 1881, higher than any civilised country except Belgium, has taken place far more in manufacturing than in agricultural districts, and has necessitated a great change in our supply of food. Previous to 1780, though luxuries were imported, the staple food-stuffs, corn, meat, cheese, &c., were produced at home; now, on the other hand, we import more than one-third of our meat, half of our cheese, and nearly two-thirds of our wheat. Owing to our luxuriousness and to this large importation of food, averaging 212 lbs. annually per head, the average annual cost of food per head in England, 13*l*. 9*s*., is higher than that in any other country. When by the scarcity of our coal our pre-eminence in heapness of manufactures becomes a thing of the past, the means of paying for this food will gradually cease, and the pressure of population, together with the increased cost of the necessaries of life, by emigration, by an increased death-rate, and by a reduced birth-rate, will change the England of to-day into a country like the England of 1780,—a country with a comparatively scanty population, with few manufactures, supporting themselves by the produce of their fields, and looking back on the England of to-day as the Spaniard now looks back on the Spain of Philip II.—of Philip, the husband of Mary of England, the ruler of Spain, Portugal, the Netherlands, the Milanese, of Malabar, Coromandel, and Malacca—of Philip, whose father had sent Cortez to conquer Mexico, and Pizarro to Peru, and who himself, by the conquest of Portugal, had annexed the valuable province of Brazil. Looking at such a picture, is it impossible that the England which now rules over 8,600,000 square miles, containing 283,000,000 inhabitants, should shrink to its former limits of 122,000 square miles, with 8,000,000 inhabitants?

Finally, let us consider if anything can be done to defer or mitigate this change in the condition of our descendants. After discussing and rejecting the expediency of limiting or taxing our output or export of coal, on the ground that any such measure would impose a serious burden upon our manufactures and commerce, and in fact produce the very result we are trying to avoid, Prof. Stanley Jevons proposed that instead of relieving ourselves by the remission of taxation, we should relieve our descendants by making a serious effort to pay off the National Debt. The amount of the debt, which was 900,000,000*l*. in 1815, was 839,918,443*l*. in 1857, and 756,376,519*l*. in 1883. Thus in 68 years about 144,000,000*l*. have been paid off. He proposed that the probate, legacy, and succession duties, as being in reality capital and not income, should be applied to this purpose. These duties amounted in 1883 to about 5,600,000*l*., and would suffice to pay off the National Debt in about 55 years. These proposals have been in part carried out. The amount of taxes remitted has of late years been considerably reduced, and in 1883 terminable annuities were created, which in 20 years will reduce the debt by 173,000,000*l*.

On the other hand, the rapid increase in local obligations to some extent renders nugatory this attempt at national economy. It is somewhat difficult to obtain accurate data on these points, but the bonds of the Metropolitan Board of Works, of Liverpool, of Manchester, and of Leeds, quoted on the Stock Exchange, represent a sum of 34,000,000*l*., and no doubt other towns are following far too rapidly in the same direction. Of course some of this expenditure represents profitable enterprises, such as the supply of gas and water, but it is to be feared that a considerable amount has been spent in ways less directly or indirectly remunerative.

If, then, we are unable to arrest the action of those physical and commercial laws which will press with more and more severity on our descendants, let us do what we can to mitigate their fate by using every exertion to avoid unnecessary increase in our obligations, and to reduce those transmitted by our fathers. It would probably be well also to appoint a fresh Royal Commission to investigate more accurately than has yet been done the various data upon which these calculations depend, to make more widely known any improvements made during the last thirteen years which may prolong the duration of our coal, and to consider the most important financial questions which are involved in this inquiry.

And at last, when the worst comes to the worst, we may take comfort from the thought that, beyond the four seas, new Englands, as yet hardly conscious of their capacities, stretch east and west, and that the New Zealander, who a few years hence may moralise on the last stone of London Bridge, will mingle reverence with his philosophy, for he will be no dark-skinned, far-off cousin, but a ruddy, healthy grandchild.

SYDNEY LUPTON

INVIGORATION OF POTATOES BY CROSS-BREEDING

SOME interesting experiments on the potato were tried at Reading last summer. Most persons are aware that changes which are called "improvements" from a commercial point of view have been effected among the plants of the farm and garden in recent years by "hybridising," and that the usual result of hybridising plants is to invigorate them. Mr. Darwin explains the law which horticulturists avail themselves of in the improvement of plants when he says, "All forces throughout Nature tend towards an equilibrium, and for the life of each organism it is necessary that this tendency should be checked" ("Animals and Plants under Domestication," vol. ii. p. 130). He adds, hence "the good effects of crossing the bre d, for the germ will be thus slightly modified or acted on by new forces." The invigoration consequent on changing seed corn from one district to another is due to the same causes, as well as the "evil effects of close interbreeding prolonged during many generations, during which the germ will be acted on by a male having almost identically the same constitution."

It would not be easy to ascertain the history of cross-breeding in gardens. Hybridisation has been called "a game of chance played between man and plants." All the great breeders of florists' flowers, and of fruits and vegetables, have practised the art successfully, but as regards the potato recent investigations have shown that the law of "changed conditions" has not been obeyed. The term "hybridising," as used by horticulturists, is a relative expression, referring sometimes to the crossing of widely distinct forms, and in other cases to the injurious union of closely connected forms. Hitherto the breeding of potatoes has involved this vicious principle of too close interbreeding, no other plant of the farm having been more constantly intercrossed.

Some years since the cross-breeding of English and American potatoes was extensively practised, and to some extent, undoubtedly, the "conditions of life" of the varieties which were brought together from either side of the Atlantic were changed; but the cultivated potatoes both of England and America belong to the same species, and having both alike become enfeebled and subject to the same disease, the experiment of interbreeding failed in its object.

Under these circumstances a veteran breeder wrote, "I have come to the end of my tether!" and he gave up the breeding of potatoes in despair. This year he has recommenced it, working hopefully with the aid of a new species, and owing this new departure to the suggestion of the eminent botanist Mr. J. G. Baker, F.R.S., of Kew.

Mr. Baker undertook a scientific examination of the various tuber-bearing species of Solanum, for the purpose of ascertaining whether *S. tuberosum*, the cultivated potato, might not possibly be invigorated by hybridising it with some other species of the family. Writing in the *Journal* of the Linnean Society, Mr. Baker says:—

"The subjects of the differential characters, the relationship to one another, and the climatic and geographical individuality of the numerous types of tuber-bearing Solanums are of great interest both from a botanical and economic point of view. As there are many points which are still to be unravelled, I propose in the present paper to pass in review the material which we possess in England bearing on the question. It was at the instigation of Earl Cathcart that I undertook the inquiry; and in carrying it out I have gone through all the dried specimens at Kew, the British Museum, and the Lindley Herbarium, have carefully studied the wild types which we grow in the herbaceous ground at Kew, and have visited the extensive trial-grounds of Messrs. Sutton and Sons at Reading, whose collection of cultivated types in a living state is probably the most complete in existence."

Bearing in mind that the potato, the most productive of our food-plants, has become the most uncertain among them in regard to its annual produce, it is not surprising that it should have been the subject of voluminous writing and continual inquiry. But, in spite of all the pains which have been expended on this stricken esculent, no one but Mr. Baker seems to have recognised the outrage of in-and-in breeding to which it has been subjected. It seems doubtful whether the numerous breeders were aware that the cultivated potato had been made the subject of continual in-and-in breeding, since it had never been crossed out of its own family during the 250 years of its highly artificial treatment in this country as a cultivated plant. Yet this has been the case, as Mr. Baker shows in his enumeration of the six tuber-bearing species of the plant. As the habitat as well as the distinctions of species of Solanum affect the subject, the following brief details have been taken from Mr. Baker's paper:—

"(1) *S. tuberosum.*—Andes of Chili, Peru, Bolivia, Ecuador, and Columbia; also in the mountains of Costa Rica, Mexico, and the South-Western United States.

"(2) *S. Maglia.*—Shore of Chili, down south as far as the Chonos Archipelago; also likely Peru.

"(3) *S. Commersoni.*—Uruguay, Buenos Ayres, and Argentine Territory, in rocky and arid situations at a low level.

"(4) *S. cardiophyllum.*—Mountains of Central Mexico, at an elevation of 8000 to 9000 feet.

"(5) *S. Jamesii.*—Mountains of South-Western United States and Mexico.

"(6) *S. oxycarpum.*—Mountains of Central Mexico."

According to Bentham and Hooker, the great genus of Solanum—the largest in the world—consists of decidedly distinct species, and if we omit some of the so-called species which are really only varieties of *S. tuberosum*, these six species alone bear tubers.

In attempting improvement by crossing the cultivated potato, it is useless to continue the system of interbreeding with its own varieties; and, on the other hand, the lesser forms of wild potatoes, such as *S. Jamesii*, a plant of eight or ten inches in height, must be rejected. Mr. Baker recommends two species as best for the breeders' purpose, *S. Maglia* and *S. Commersoni*. Both these kinds yield good crops of fair quality under cultivation, and they possess the advantage of coming from a moist climate. This is a point of great importance. When Mr. Darwin, a young naturalist in 1835, was writing his account of "The Voyage of the *Beagle*," he mentioned having seen the potato growing wild on the shores of the islands of the Chonos Archipelago, in South America, and he thought it surprising that the same plant should be found in the damp forests of those islands and on the sterile mountains of Central Chili, where a drop of rain does not fall for more than six months. The explanation of this anomalous circumstance is that the potato of the islands and lowlands belongs to a different species from that of the mountains, the latter being identical with the cultivated potato of Europe and America, while the former is *S. Maglia*, which is at any rate hardy, vigorous, and healthy, and in all respects apparently well suited for crossing with the cultivated sorts. This is the potato which Mr. Baker recommends. Earl Cathcart had asked him for any suggestions that a botanist might be able to offer to breeders founded upon scientific knowledge of the potato generally and of the geographical distribution of the family.

On this part of his inquiry, Mr. Baker observes that potato-growers work upon the assumption that the one purpose of the plant's existence is the production of potatoes, which is in fact only an incident in its life. *S. Maglia* has been grown at Kew among the herbaceous plants since 1862, and in that dry sandy soil, without manure, it produces few if any tubers, or only of small size. On the other hand, two tubers were sent to Chiswick and grown there in the gardens of the Royal Horti-

cultural Society in richly-manured land, and the produce proved abundant, yielding, the first year, 600 tubers as large as pigeons' eggs. The constitutional effects of the abnormal production of tubers which high farming occasions have been often noticed. On this point Mr. Baker says: "Any plant brought to the tuber-bearing state is in a disorganised, unhealthy condition, a fitting subject for the attacks of fungus and aphides."

It frequently happens, moreover, that the cultivated potato loses its power of producing flower and of reproducing itself by means of seed. The illustrious horticulturist, Thomas Andrew Knight, discovered the relationship of tuber to fruit, and demonstrated with great clearness the principle that, in proportion as plants or animals waste in one direction, they must economise in another. Knowing the difficulties that lay in the path, Lord Cathcart intrusted some tubers of *S. Maglia* from the coast of Chili to those eminent potato-breeders, whose collection of varieties Mr. Baker refers to as the largest in the world, Messrs. Sutton and Sons of Reading. After very careful treatment of the tubers, which were about the size of walnuts, the young plants were committed to the open ground, where, making our story as short as possible, they grew vigorously and produced numerous blossoms having white corollas, which are characteristic of wild potatoes, the corollas of cultivated breeds being purple and lilac. But whatever the seed-bearing capabilities of *S. Maglia* may be at Valparaiso and in the Chonos Archipelago, when growing in a state of nature, it did not produce a single seed in Messrs. Suttons' trial-grounds, except in the case of some blossoms which were hybridised. It is needless to describe the particular means by which this delicate operation was effected. It happens, however, that the manipulator was the same veteran breeder who had grown despondent about potatoes until this new departure had been achieved. Last winter he had reached the end of his tether. Since then he has hybridised *Solanum Maglia*, and is anticipating the conquest of new potato worlds in his old age.

The crop at Reading this first year is good, and the tubers are as large as those of ordinary potatoes. The foliage is luxuriant, growing as high as a common table. Certain other sorts have shown no capacity for "improvement." *S. Jamesii*, for example, grows at Reading only eight or ten inches high, and would scarcely be recognised as a potato except by a botanist. *S. Commersoni*, known by the synonym *Ohrondi*, from the name of a French naval surgeon who brought it to Brest from Goritti Island, at the mouth of the Rio de la Plata, was obtained last spring by Messrs. Sutton from M. Blanchard of the Gardens of the Naval Hospital at Brest. Messrs Sutton have wisely acted throughout these trials under scientific advice, and *S. Commersoni* had been named by Mr. Baker as one of the few species which are known at present to have shown a capability of "improvement." Unfortunately it resisted all the attempts that were made last summer at Reading to hybridise it with the cultivated sorts. We may hope, however, to become possessed of this and other hybrids before breeders have travelled far on the road which has now been opened to them. Previous attempts to overcome the potato disease had been mainly directed to the doctoring of the soil, or plant, and to direct attacks upon the disease. Every gardener and farmer may now welcome the birth, so to speak, of a hybrid, which, we may hope, will enable the potato plant to resist the attack of parasites, and especially those of the devastating fungus *Peronospora infestans*. H. E.

ON THE EVOLUTION OF THE BLOOD-VESSELS OF THE TEST IN THE TUNICATA

It is well known that the test or outer tunic in most Simple Ascidians is penetrated by a system of tubes containing blood. These "vessels" were shown in 1872 by Oskar Hertwig[1] to be developed as ectodermal evaginations containing prolongations from one of the blood-sinuses of the underlying mantle. Each vessel is divided longitudinally into two distinct tubes by a septum of connective tissue, and after ramifying through the test may be found to terminate, generally close to the outer surface, in one or more rounded enlargements or bulbs which are usually known as the "terminal knobs" (Fig. 5, B). The two blood-tubes join in the terminal knob where the septum ends, and this allows the blood which flows outwards through the one tube to turn in the bulb and flow back

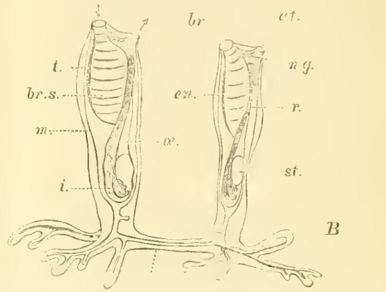


Fig. 1.—*Clavelina lepadiformis.* Enlarged from a specimen dredged off Dartmouth. *br*, branchial aperture; *at.*, atrial aperture; *br.s*, branchial sac; *t*. test; *m*, mantle; *œ*, œsophagus; *st.*, stomach; *i*, intestine; *r.*, rectum; *en.*, endostyle; *n.g*, nerve ganglion; *s.*, stolon; B, part of the stolon becoming enlarged to form a bud.

along the other tube. Thus temporarily the one tube acts as an artery and the other as a vein, but of course they exchange functions at each reversal of the heart's action.

This system is usually regarded as being merely the blood-supply to the test; but Lacaze-Duthiers[2] has pointed out that the hair-like projections from the test to which sand-grains adhere in most Molgulidæ, are merely special developments of the terminations of the vessels, and I have suggested[3] that they are also homologous with the vessels in the stolon of the Clavelinidæ from which buds are produced (Fig. 1).

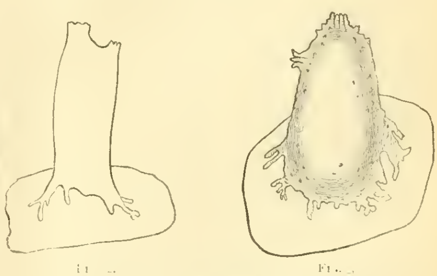


Fig. 2.—*Ciona intestinalis* from Lamlash Bay, Arran. Natural size.
Fig. 3.—*Ascidia aspersa* from Lamlash Bay, Arran. Natural size.

The extent to which this blood-system of the test is developed varies greatly in the different species of Simple Ascidians. In some, such as *Ascidia plebeia* and *Corella parallelogramma* (Fig. 4), it is very rudimentary, if indeed it can be said to be present; while in others, such as *Ascidia mentula*, *Ascidia meridionalis*, and *Ascidia*

[1] "Untersuchungen über den Bau und die Entwickelung des Cellulose-Mantels der Tunicaten," *Jenaische Zeitschrift*, Bd. vii. p. 46.

[2] *Archives de Zoologie expérimentale et générale*, t. iii. p. 314, 1874; and *Comptes Rendus*, t. lxxx. p. 600, 1875.

[3] *Proc. Roy. Soc. Edin.* 1879-80, p. 719.

reptans, the test is penetrated in all directions by a well-developed system of tubes with large and numerous terminal bulbs. A series of Simple Ascidians could be formed showing all conditions between these two extremes, and also exhibiting very varied arrangements in regard to the disposal of the vessels in the test, their modes of branching, and the relative numbers and sizes of the terminal bulbs. But perhaps the most interesting modifications of all are those met with in some of the members of the remarkable deep-sea genus *Culeolus*. There we find a great development of the vessels and their enlargements just on the surface of the test, and separated from the surrounding medium by a very thin layer of tissue. When describing this system in 1882,[1] I suggested that in these species it might act as an accessory organ of respiration, and I have lately shown[2] that an investigation into the condition of the corresponding system of vessels in some of the Compound Ascidians supports this idea, the chief arguments in favour of which are:—

(1) The disposition of the tubes and cavities in the different regions and layers of the test, and the anatomical characters of the system.

(2) The relation which exists in many groups of Ascidians between the branchial sac (the chief organ of respiration) and the system under discussion,—where the branchial sac is large and highly developed, the vessels in the test are few and small; but where the branchial sac is small, simple, and apparently inefficient, the vessels in the test are numerous, of large size, and disposed in such a manner as to suggest that they are concerned in the aëration of the blood.

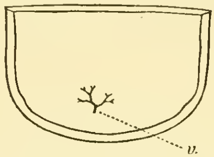


Fig. 4.—*Corella parallelogramma*. The posterior part of the left side of the test of a specimen from Loch Fyne. Twice the natural size. *v.*, the system of vessels.

It is obvious that it would be advantageous to an Ascidian if its test could act even to a slight degree as an accessory respiratory organ, by allowing the blood circulating in its superficial layers to be brought into such close relation with the external medium as to render possible a certain amount of oxidation. And consequently it is easy to imagine the process of evolution of such a complicated system as we find in *Culeolus murrayi* from a few simple vessels like those in the test of *Corella parallelogramma* (Fig. 4). But it is probable that the common ancestor of Simple and Compound Ascidians had no blood-spaces in its test. There are none in the "Haus" of the Appendiculariidæ; and in *Clavelina*, which may be regarded as nearer to the first Simple Ascidian than any other form known, there are no vessels in the test except those of the stolon. Some structure must therefore be looked for from which the first respiratory blood-system of the test may have been evolved, and such a structure is to be found, I believe, in the gemmiparous stolon of the Clavelinidæ.

Clavelina (Fig. 1), which from other independent evidence I regard as the most primitive form of Simple Ascidian known to science, is one of the so-called "Social" Ascidians in which the members of the colony are united by a creeping stolon containing "vessels" (that is a prolongation of the ectoderm and the mantle, and a blood-tube) which place the circulatory systems of the various members in communication, and from the ends of which, in prolongations of the test (as at B, Fig. 1), new members are produced by gemmation. It is possible that this system may act in some slight degree as a respiratory organ, but its chief function, and probably its only one, is the asexual production of new individuals.

The ancestors of the remaining Simple Ascidians diverged from the ancestors of the Clavelinidæ, and lost the power of reproducing by gemmation, but in many of the least modified of the Ascidiidæ we still find processes from the posterior end of the test which contain vessels, and so closely resemble the stolon of *Clavelina* in all particulars that there can be no doubt that they are persistent rudiments of that structure.

In *Ciona*, which is certainly one of the most primitive of the Ascidiidæ, vessels are only present in the posterior part of the test, and here we frequently find them drawn out into long processes of the test, which have the greatest possible resemblance to stolons (Fig. 2), and are doubtless their homologues, although they no longer function as bud-producing organs. They are useful as adhering organs, and they have probably to a slight extent commenced to perform a respiratory function.

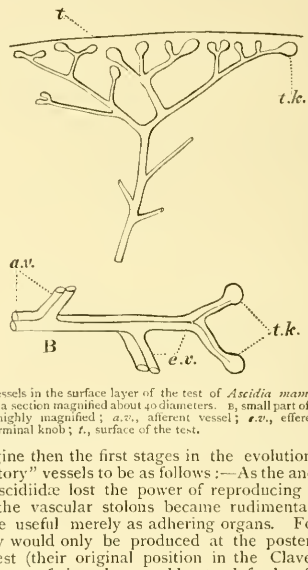


Fig. 5.—Vessels in the surface layer of the test of *Ascidia mammillata* as seen in a section magnified about 40 diameters. B, small part of the system more highly magnified; *a.v.*, afferent vessel; *e.v.*, efferent vessel; *t.k.*, terminal knob; *t.*, surface of the test.

I imagine then the first stages in the evolution of the "respiratory" vessels to be as follows:—As the ancestors[1] of the Ascidiidæ lost the power of reproducing by gemmation, the vascular stolons became rudimentary, until they were useful merely as adhering organs. For some time they would only be produced at the posterior end of the test (their original position in the Clavelinidæ), but in course of time they would extend further forwards along the left side of the body (the side upon which most Simple Ascidians lie) so as to anchor the animal more securely, and we even find them occasionally in this condition in *Ciona intestinalis* and in *Ascidia aspersa* (Fig. 3).

They would then probably (in some not very remote ancestor of *Ciona*) begin, while still acting as adhering organs, to be of some slight use in respiration, and would, consequently, by the action of natural selection, be evolved gradually into a larger system of vessels extending over a wider area of the test. And here might be shown a series of the Ascidiidæ passing from *Ciona* (Fig. 2) through *Corella* (Fig. 4), and *Ascidia plebeia*, in which the system is still very feebly developed and confined to the posterior half of the left side of the

[1] "Zoological Reports of the *Challenger* Expedition," Part xvii. pp. 90 and 279.

[2] *Proc. Lit. and Phil. Soc.*, Liverpool, session 1884-85.

[1] See phylogenetic table in "*Challenger* Reports," part xv " p

test, by gradual stages to *Ascidia mammillata* (Fig. 5), where the vessels are numerous all over the test, branch freely in its outer layer, and terminate close to the surface in large ovate bulbs, which are usually found filled with blood-corpuscles.

The only part of this history which presents any difficulty is the passage from the Clavelinid to the Cionid arrangement, from the gemmiparous stolon to the first traces of a respiratory system of vessels. This can, I believe, be most satisfactorily explained by assuming that the rudimentary stolons after they had lost their primary function became useful as adhering organs (Figs. 2 and 3), and consequently were retained or possibly increased by the action of natural selection, until their respiratory function became established.

I hope to work out the modifications of the system throughout the various groups of Ascidians in detail, and the results will probably be given in Part II. of the Report on the *Challenger* Tunicata.

W. A. HERDMAN

NOTES

THE Council of the Royal Astronomical Society have awarded their gold medal to Dr. W. Huggins for his researches on the motions of stars in the line of sight and on the photographic spectra of stars and comets. The presentation takes place at the annual meeting next month. This is the second time that Dr. Huggins has received the medal, he having, in 1867, in conjunction with the late Prof. Miller, received it for his researches in astronomical physics.

THE will of Mr. George Bentham, who died in September last, has been proved by Sir Joseph Dalton Hooker and the Right Hon. Sir Nathaniel Lindley, the executors, the value of the personal estate amounting to over 23,000*l*. The testator bequeaths, among other sums, 1000*l*. each to the Linnean Society of London and the Royal Society Scientific Relief Fund. The residue of his real and personal estate is to be held upon trust to apply the same in preparing and publishing botanical works, or in the purchase of books or specimens for the botanical establishment at Kew; or in such other manner as his trustees may consider best for the promotion of botanical science.

AT the meeting of the Colonial Institute on Tuesday, Gen. Sir Henry Lefroy read a paper on the meeting of the British Association in Canada. Sir Lyon Playfair, M.P., referred to the visit of the British Association as marking a point in the advance of civilisation. Canada's position of having federated, not under the pressure of war, but in a time of profound peace, was unique in the history of the world. The science of Great Britain belonged to the Empire, and it was right that Canada should be the first to try to federate the science of the United Kingdom, and distribute it over the Empire. What Canada wanted was not pure science, but applied science, to bind together her vast territory by railways. But knowing that applied science did not come except pure science preceded it, Canada had had the forethought and wisdom to welcome that pure science to the Dominion. Sir Lyon gave a humorous account of an adventure he had in a wild part of Ottawa with a Scotch mining manager. It turned out that the manager, when in Scotland, had attended the Mechanics' Institute at Glasgow, and afterwards the evening classes at the Andersonian Institution, obtaining a knowledge of chemistry and mineralogy, which had stood him in good stead on emigrating to Canada. From his compatriot he (Sir Lyon) heard of many other Scots of a like type, all of whom had got on well, from the scientific education they had acquired at similar institutions. For such men he did not know any better country than Canada to find openings for getting on in the world. Prof. G. T. Bonney spoke at some length of the interesting geological formation of Canada, and said he believed that the district north of the St. Lawrence was rich in valuable minerals, and that exploring parties for their discovery should be organised to supplement the systematic geological survey which was being slowly conducted. He condemned the wasteful treatment of the forests that was going on in some of the parts he had visited, and suggested that it was a matter which should engage the attention of the Dominion Government.

ON Tuesday evening Sir Frederick Bramwell gave an address at the Institution of Civil Engineers on his assuming the chair for the first time since his election as president. Sir Frederick's subject was suggested to him by the forthcoming Exhibition of Inventions, his address consisting mainly of a review of some of the most remarkable recent inventions in the application of science to engineering. Sir Frederick has apparently given up hope of our being able to put the tides to any practical use, and hints that Khartoum might have been relieved long ago had our aeronauts been as inventive, or our War Department as enterprising, as those of France.

M. COCHERY, the French Minister of Posts and Telegraphs, was present, on January 2, at Rouen to witness some interesting experiments in telephoning to a great distance. The object was to test the results of the application between Rouen and Havre, a distance of 90 kilometres, of M. Van Rysselberghe's system of instantaneous transmission. The experiment was perfectly successful, and during more than one hour, messages were exchanged between Rouen and Havre. The Minister announced, on leaving Rouen, that the communication would be open to the public in about a fortnight. Since January 1 the first telephonic offices have been open in Paris, and it is probable that communication will soon be established between Paris and Rouen.

MR. LANT CARPENTER lectures on Sunday at the Sunday Lecture Society, on "The Life and Work of Sir William Siemens," illustrated by experiments, diagrams, and the oxy-hydrogen lanterns. Mr. Carpenter has, we understand, obtained some special materials, of which he will make use in his lecture.

REPORTS from Brussels state that the Spanish earthquake, or a similar simultaneous earthquake, was felt at the Royal Observatory there. The Observatory is stated not to be provided with special instruments for recording earthquakes, as these phenomena are so rare and slight in Belgium. It is said that on December 26 last, the day succeeding the first great shock of the Spanish earthquake, one of the astronomical clocks in the principal meteorological station in the Boulevard de l'Observatoire was stopped, and the other went irregularly. The officer charged with attending to them perceived that the pillars on which they rested had been displaced, and were no longer vertical. On the evening of the same day, M. Lagrange, when about to make some observations, noticed that the large telescope was also displaced. It appears from this that the undulations of the crust of the earth, which have had such disastrous effects in Spain, extended as far as Brussels, and although their effects were not generally appreciable in the latter city, yet they were noticeable in the case of delicate instruments, such as astronomical clocks. It would be interesting to have a precise, authentic statement on this subject, and also to learn whether similar effects were noticed anywhere else in Europe during the last week of the old year.

AT a recent meeting of the German Asiatic Society of Japan a paper was read by Dr. H. Muraoka of Tokio, on the magic mirror of Japan. It is generally supposed that its magical quality was discovered only recently; but it was, says Dr. Muraoka, known for a long time in Japan. Old ladies have

told him that in their youth, fifty years since, they frequently noticed, when at toilet, that the reflection of the sun from the mirror on the wall or ceiling contained the figures or letters on its back. It is said to have been known to the Romans in connection with some of their mirrors, and any one concealing a mirror possessing this quality was arrested as a sorcerer; but the authority for this statement is not given. The subject is engaging considerable attention, as will be seen from the fact that in recent years a list of fourteen writers on the subject is quoted, from Stanislas Julien, in 1847, to Messrs. Ayrton and Perry quite lately; and, as the subsequent discussion showed, there are omissions even in this list. These writers, especially the two latter, have demonstrated beyond doubt that unequal convexities in the mirror beget its magical quality. The polished surfaces are convex, but the convexity is not continuous, and is broken in certain places. After going over what had already been done on the subject, and its results, the author described his own investigations. The riddles of the mirror are far from being all answered by the discovery of unequal convexity. For example, how is the inequality caused—by pressure, heat, or by changes in the molecular tension of the metal plates? The writer tried many experiments to answer the question, and he succeeded by means of chemical agents in drawing lines on the flat back of a mirror, which were reproduced on a reflected image from the front. His results are: That the irregularity in the convexity is caused by the grinding, which alters the molecular tension, that the magic mirror may be produced at will (it was generally supposed to be the work of chance alone), and that the magical quality attributed to it is not confined to Japanese bronze, but is common to all firm, elastic substances. A curious process employed by mirror-workers is described by Dr. Muraoka: it appears to be one of the secrets of the craft. If the surface of a mirror has been made concave by mechanical pressure, the injury is not repaired, as might be expected, by hammering the other side, or otherwise forcing the metal back into its place. The workman takes an iron tool with rounded, but slightly rough, top, and rubs the concave portion of the mirror in all directions, until a fine network of scratches has been formed. The place then rises of itself, and, instead of being concave, becomes more convex than the rest of the surface. This convexity is then shaved away with a knife made for the purpose, until it becomes even with the rest of the mirror. When this is done the whole surface is again ground, polished, and amalgamated.

A STRANGE Japanese custom has, according to the *Japan Mail*, been brought to light by the working of the conscription law. The head of a certain family was instructed that the time had come for his son, whose name was on the census list, to undergo medical examination prior to actual enlistment. The father lost no time in informing the authorities that the individual referred to, though bearing a male name, was his daughter. He explained that having lost two daughters, both about one year old, he had been driven to this expedient to keep the third alive. It appears, further, that in many districts of Japan people still resort, in their anxiety to prolong the lives of their children, to the custom of bestowing upon their offsprings names ordinarily given to infants of the opposite sex, whenever death has made frequent visits to their households. The present case occurred in the capital.

AN important memoir by Lieut. Casey on the North American species of beetles of the sub-family *Stenini* has just been published. It extends to over 200 octavo pages, and describes in minute detail nearly 170 species, of which the greater part are new, and should form one of the most important contributions to systematic entomology in the States that have appeared. "*Stenus*," in the broad sense, is well defined as a whole, but is notoriously difficult in detail. When genera become unwieldy owing to the mass of species included, it is a convenience to students if they can be split up by recognisable divisional characters. Acting on this idea, Casey has split "*Stenus*" into *Stenus* and *Areus*, on tarsal structure. This subdivision equally affects European (and even British) species.

MR. ALDERMAN W. H. BAILEY, as President of the Manchester Society of Engineers, gave an interesting inaugural address on the 10th inst., his subject being "The Reign of Law in Relation to the Unification of Engineering Work." "The reign of law," Mr. Bailey stated, "is imperial in the domain of the engineer. He deals with forces which have definite, fixed values. If he perceives a quantity or a force he knows that he can identify the same measure or quantity of the like whenever he meets with its equivalents under equal conditions. We know that chance does not rule, and if there be conditions that are indefinite or obscure to us it is not because there is no law, but because we are ignorant of its records." This text Mr. Bailey illustrated by reference to the necessity of exact measurement, supporting his position by numerous examples.

PROF. F. ELGAR is about to deliver a special course of evening lectures, in the University of Glasgow, upon "The Buoyancy and Stability of Ships." The course will consist of twelve lectures, commencing on the 22nd inst. These lectures are intended not only for students of this branch of the science of naval architecture, but also for the convenience of draughtsmen and others who are employed in shipyards during the day, and who are unable to attend the regular University classes.

IN the report of the Meteorological Service of Canada for 1884, attention is again called to the advisability of establishing a marine department in connection with the Meteorological Service for the purpose of organising a system of observations on the ocean by steamers crossing the Atlantic and by those trading with ports in Brazil and the West Indies. Canada, having great shipping interests, should, it is thought, take her part in the great international work now going on of charting the meteorological conditions prevalent over the Atlantic, and in the general development of ocean meteorology. Such observations in the North Atlantic would, it is stated, be of great value, especially in perfecting knowledge of the movements of a particular class of storms. Recent investigations on the subject of the climatic relations of Canada to European countries show that the Dominion has the latitudes of Italy, France, Germany, Austria, the British Islands, Russia, Sweden, and Norway, and has as many varieties of climate as have those countries. There is greater cold in winter in many of the latitudes of Canada than in corresponding latitudes in Europe, but the summers are about the same. The most southern part of Canada is on the same parallel as Rome, Corsica, and the northern part of Spain; it is farther south than France, Lombardy, Venice, or Genoa. The northern shores of Lake Huron are in the latitude of Central France, and vast territories not yet surveyed lie south of the parallel of the northern shores of Lake Huron, where the climate is favourable for all the great staples of the temperate zone.

WITH the new year *Cosmos*, the well-known French scientific journal, will enter on a new period. The size will be increased, in order that larger illustrations may be introduced. It will in future consist of 64 columns, two on a page, each of which will contain more matter than its present page.

THE additions to the Zoological Society's Gardens during the past week include a Pig-tailed Monkey (*Macacus nemestrinus* ♂) from Java, a Macaque Monkey (*Macacus cynomolgus* ♀) from India, a Vulpine Phalanger (*Phalangista vulpina* ♀) from Australia, presented by Mr. J. Church Dixon; a Mouflon (*Ovis musimon* ♂) from Corsica, presented by H.R.H. the Duke of Edinburgh, K.G.; a Vulpine Phalanger (*Phalangista vulpina*)

from Australia, presented by Mr. B. C. Parr; a Short-toed Eagle (*Circaëtus gallicus*) from Suez, presented by Capt. H. E. Robbins; a Lacertine Snake (*Cœlopeltis lacertina*) from North Africa, presented by Mr. R. F. Sibbald; a Rose-crested Cockatoo (*Cacatua moluccensis*) from Moluccas, deposited; a Black and Yellow Hawfinch (*Mycerobus melanoxanthus*) from Yarkland, a —— Pastor (*Sturnia* ——) from the Andaman Islands, four Starred Tortoises (*Testudo stellata*) from India, a Tuberculated Iguana (*Iguana tuberculata*) from South America, purchased.

OUR ASTRONOMICAL COLUMN

The Naval Observatory, Washington.—The Report of the Superintendent of this establishment, Commodore S. R. Franklin, to the Navy Department, for the year ending October 31, 1884, has been issued. Great stress is laid upon the importance of commencing the buildings for the new Observatory. The present site is stated to be notoriously unhealthy, and the buildings are in a dilapidated state, and, as the ground for the new Observatory has been purchased and the plans made and approved, the Superintendent urges that Congress should be appealed to during the coming session for a portion at least of the funds required for the new Observatory. His estimate "For the purpose of erecting a new Naval Observatory and necessary buildings upon the site purchased under the Act of Congress, approved February 4, 1880," amounts to 586,138 dollars, or approximately 120,000*l.* The 26-inch equatorial was chiefly employed in observations of the satellites of Neptune, Uranus, Saturn, and Mars; in the case of Uranus, the observations were confined mostly to the two outer satellites, and have now been discontinued, as the favourable time for determining the position of their orbits has passed. Since this instrument was mounted in 1873 observations of the faint satellites of the planets have constituted its main work, and the laborious discussion of the observations, with the view to the correction of orbital elements, was commenced in earnest in August 1883, and is now in a very advanced state, particularly as regards the satellites of Saturn. A report from Prof. Harkness, in charge of the work for the Transit of Venus Commission, is appended: the measurements of the negatives obtained at the various stations was completed last August; the number of photographic plates giving satisfactory results is 932 for the northern and 639 for the southern hemisphere. Prof. Harkness enters into details with respect to these measures, and the method of conducting them, for which reference must be made to the report. The Superintendent regrets that the printing of the Washington observations is not so advanced as is desirable, and proposes applying to Congress for a sum of 1000*l.* annually for a few years, in order to bring up work to date, after which a smaller sum would allow of the due publication of the observations.

The Dearborn Observatory, Chicago.—The report of the Director of this Observatory, Prof. G. W. Hough, dated June 18, 1884, has been received within the past week. The work with the 18-inch equatorial was confined, as usual, during the previous year to the observations of a few special objects, including Pons's comet of 1812 on its reappearance, difficult double-stars, the planet Jupiter, and the satellites of Uranus. Thirty-two new double-stars, most of which are difficult, were detected. The companion of Sirius was measured by Prof. Hough on eleven nights, and by Mr. Burnham on ten nights, the mean result being

1884·185 ... Position, 36°·6; Distance, 8″·45.

which, with the observations of recent years, seems to indicate that the period of revolution of the companion is longer than that indicated by theory. The disk of Jupiter was observed on every favourable occasion, and micrometric measures made on the principal spots and markings, including the great red spot first remarked in 1878. With best vision the colour of this object in 1883-84 was "unmistakably a pale pink." The spot is stated to have maintained its size, shape, and outline during the five years it has been observed at Chicago; in this respect experience there has not fully accorded with the impressions of some observers, that the spot had "lost its outline, and become merged in a faint belt on the following end." The most marked change has been in its degree of visibility, but it was seen at Chicago as long as the planet was observable. Prof. Hough adds that from 1879 to 1883 the spot had a retrograde drift in longitude upon the surface, or, in other words, the apparent rotation of Jupiter was increased from 9h. 55m. 34·0s. in 1879 to 9h. 55m. 38·4s. in 1883. During the last opposition this drift appears to have nearly ceased. The mean period from September 12, 1883, to June 11, 1884, comprising 660 rotations, is 9h. 55m. 38·5s., and the mean for the whole five years of observation is 9h. 55m. 37·0s. The report is accompanied by six tinted lithographs of the appearance of Jupiter's disk. Saturn was frequently examined with the view to detecting markings on the rings, but all observations so far in this direction have been negative. While the rings have been sharply defined, and even the boundary of the dark ring well seen, "nothing indicating a division in the outer ring has ever been noticed." This is not in accord with the conclusion of many other observers provided with telescopes of less optical capacity than the Dearborn refractor.

GEOGRAPHICAL NOTES

A so-called "envoy" of the Mayor of Timbuktu, lately arrived in Paris, has been received by the French President, and introduced to the Geographical Society at its last meeting. On this occasion it was stated that there is no Sultan or military authority in this famous metropolis of Negroland, but only a body of merchants who yearly elect a kind of mayor from amongst themselves. This statement is not quite correct, and, as little is known regarding the internal affairs of the city, the following facts will be acceptable:—For over 200 years Timbuktu has been administered by a "Kahia," a kind of burgomaster, originally appointed by the Emperor of Marocco from the Moorish Andalusian family of Er-Rami some time after the expulsion of the Arabs from Spain. The office became hereditary in this family, and the present Kahia, or "Amir," as he now affects to call himself, is Muhammed Er-Rami, whose Negroid features are the result of long alliances with the surrounding Souhray population. He commands little influence, and is practically a mere puppet in the hands of whichever of the rival Arab, Imosharh (Berber) or Fulani (Fulah), factions happens for the time being to have the upper hand. The Imosharhs command the whole district between Timbuktu and Arawán, and their Sheikh or "Sultan," Eg-Tandagumu, seems to draw his chief supplies from the plundered caravans passing through his territory. The Arabs, as in the time of Barth, are still ruled by the head of the illustrious El-Bekay family, a branch of the Kuntza tribe, whose present chief is Sheikh Abadin. His policy has long been to side with the Fulani, whose power here, as elsewhere in the Western Sudán, is constantly on the increase, and who threaten to become absolute masters of Timbuktu unless this place falls into the hands of some European power advancing from the west or penetrating up the Niger valley from the south.

According to the *Turkestan Gazette*, Dr. Grishimailo, the traveller and entomologist, has concluded his investigations into the natural history of Turkestan for the present. He began his travels in the Fergana Valley, and from thence he went into the Altai region, which he examined thoroughly. In the course of the summer he visited Osch, Arawan, Nankat, Utch-Kurgan, Shahimardan, Karakazyk, Koksu, Tekelik, the River Balykty, Karamuk, and Zanku; on his return he visited Karamuk, Jirgetal, Sarzbulak, Koksu, Altyumazar, and went on foot through the Trans-Altai Mountains to Bordooba and Karakul. The geological collections are very considerable. In lepidoptera alone there are 17,000 specimens, amongst them being many new kinds. The expedition was also a success from an ethnographical and anthropological point of view. Many heights were measured and thermometrical observations made throughout the whole journey. The traveller met many evidences of the existence of a glacial epoch in Central Asia: amongst these are mentioned the presence of forms in Thian-shan, which hitherto have only been found in Labrador, Greenland, Lapland, and the Swiss Alps. Next year Dr. Grishimailo contemplates visiting the western offshoots of the Thian-shan range, because this locality has never yet been examined thoroughly from a geological point of view.

At the last meeting of the Geographical Society of St. Petersburg, M. Beliaffsky made a communication respecting the journey which he undertook in order to explore the central road

leading to the interior of Central Asia. This road is much shorter than the usual route, but was considered until very lately as the worst and most difficult. But upon examining the obstacles presented by the road, and principally the alleged impossibility of effecting a passage through Mertvy, Koultouk, Oust-Oust, &c., M. Beliaffsky found the assertion to be erroneous, and therefore pronounces himself in favour of the road he has explored. In order to render it still more easy, he proposes that regular communication should be established on the Caspian Sea between Astrakhan and Cesarewitch Bay, that two lighthouses, at least, should be constructed; that a steam navigation service should be established on the Amu-Doria, and a road practicable for vehicles made through the sands between the Amu-Doria and Khiva.

THE last (xi.) of Mr. Lansdell's series of interesting letters from Central Asia in the *Times*, describes his journey by boat down the Oxus, from Charjui to Khiva. In referring to the fish of the Oxus, he mentions the *Scaphyrincus*, a kind of sturgeon, the discovery of which in Central Asia, a few years ago, made quite a flutter among the students of ichthyology by reason of its resemblance to one of the North American sturgeons, which was found for a long time in the Mississippi only, until Fedchenko discovered one in the Syr Daria, and subsequently M. Bogdanovitch found another species in the Lower Oxus. The Oxus fish is known as *Scaphyrincus kaufmanni*. M. Bogdanovitch points out its interest from a geological point of view. "In the Palæozoic period," he says, "the ganoid fishes used to inhabit all the waters of the world in a great number of forms, comprising almost entirely the ichthyological fauna of that period. At the period of the Devonian formation this group of fishes seems to have reached its highest development, and in the strata of this formation are preserved the most numerous remains of its representatives. In the succeeding geological period this group appears to fall and die out, giving place to a group of *Teleostei* or bony fishes, which inhabited at that time all the waters of the world in a number of forms."

ON December 3, 1884, was celebrated, in the Scandinavian kingdoms, the bi-centenary of the birth of Ludwig Holberg, "the northern Molière" Prof. Erslev took advantage of the occasion to bring to the notice of the Danish Geographical Society the services to geography of the great dramatic poet in his generation. When Holberg was appointed Professor of History and Geography in 1730, the latter science was in a bad plight everywhere, and especially in Denmark. According to the curriculum, the Professor had to hold a reading once a fortnight on geography, but it is not known whether these readings actually took place. Holberg's great interest in geography is evident, not only from his own geographical writings, but also from many of his observations elsewhere. He betook himself with much eagerness to the study of the subject; in a preface to Van Howen's "Journey to Russia" (1743) he recommended others to write similar descriptions of their journeys. His own first geographical work was a description of Denmark and Norway (1729), the second "An Account of the Celebrated Norwegian Commercial City, Bergen" (1737), which is said to be useful even still. His third work was a geographical textbook in Latin, entitled "Ludovici Holbergii Compendium Geographicum in usum Sudiosi Juventulis," of which there were several editions both in Copenhagen and Leipzig. The work was translated into English in 1758, with a small universal history by Holberg. Some editions of it belong now to the class of bibliographical rarities. His work was edited after his death by Pastor Jonge, but Holberg's fifty-eight small obtavo pages grew into seven large quarto volumes.

CAPT. WILLARD GLAZIER, of the United States Navy, has communicated to the English Royal Geographical Society his discovery of the true source of the Mississippi. This has long been a vexed question, and in June, 1881. Capt. Glazier organised and led an expedition with the object of finally settling the matter. The expedition proceeded in canoes *viâ* Leech Lake to Lake Itasca, and, accompanied by an old Indian guide, pushed forward to the south; and the captain was rewarded by the discovery of another lake of considerable size, which proved to be, without the shadow of a doubt, the true source of the Mississippi. It is in lat. 47° 13′ 25″, and the lake is 3 feet above Lake Itasca, the hitherto supposed source of the river. The Mississippi may, therefore, be said to originate in an altitude 1578 feet above the Atlantic Ocean, and its length, taking former *data* as the basis, may be placed at 3184 miles. The tract of country in which the river originates is a remote and unfrequented region.

AN embassy of two hundred and fifty representatives of the aboriginal tribes of Western China, which recently arrived at Pekin, has led a writer in the *North China Herald* to give some information with regard to these little-known peoples. These tribute-bearers are under the charge of native chiefs, who are responsible to the Chinese authorities of the province for the maintenance of order, and the fulfilment of all recognised obligations, one of which is that of visiting Pekin once in twelve years with tribute. The localities from which they come are scattered over the country from Yennan to Kan-su, all along the Thibetan border of Sze-Chuan. At one time their name, Tu Sze, or "aboriginal officers," embraced all the aboriginal tribes in Western and South-Western China. The Chinese never had the aid of ethnology to guide them in discriminating between subject peoples by their languages, customs, physical characteristics, and religious beliefs, but they have collected the materials for judging, and we now know, generally speaking, in what category to place the different races met by travellers in Western China. The Lolos of Sze-Chuan are allied to the Burmese, the tribes represented at Pekin, who are also called Hsi Fans, are Thibetans. Both may be called the Mon-Bod family, or Western Himalaic, according as the ethnological inquirer prefers to determine his nomenclature by mountain chains, or by the most prominent race-names prevailing among the people themselves. The Thibetans and Hsi Fans prefer Bod for their race-name, as the Burmese do Mon. The rest of the aboriginal tribes in Western China and in the southern provinces, whether Miao, Yao, or Tung, seem all to belong to the Eastern Himalaic branch, or that of the Siamese, the Laos tribes, the Shan tribes of the Indo-Chinese peninsula, the Li tribes of Hainan, and the Cambodians and Cochin Chinese. The Lolos, as described by M. Baber, live in their own mountains apart, and seem to be a nation, while the Hsi Fans live in scattered tribes whose natural home is Thibet. They are short of stature, fond of red clothing, and, as to shape, adopt Chinese fashions in no small degree. Their faces are rounder than the Chinese, their heads smaller, their noses less stunted, and, while small, stand out to a point. Their eyes are small, placed in a line, and have a bright black lustre. They are a quiet race now; but history shows that they struggled bravely against the all-conquering Chinese. Details respecting the twelve Hsi Fan tribes of Sze-Chuan are to be found in numerous Chinese books, and there are also many official and private accounts of the wars which ended in their subjection.

DR. DOMENICO LOVISATO'S paper on Tierra del Fuego, reprinted from a recent number of Guido Cora's *Cosmos*, adds considerably to our knowledge of that inhospitable region and its inhabitants. The division of the latter into three distinct groups, Ona in the east, Alaculuf in the west, and Yahgan in the south, is fully confirmed. But the two latter appear to be fundamentally one, constituting a single type of "Asiatic" descent, while the first mentioned is certainly of Tehuelch (Patagonian) stock. The Onas, all hunters, number about 20 0; the Yahgans, mainly fishers, perhaps 3000; the Alaculufs, hunters and fishers, 3000; giving a total population of not more than 8000 to the whole archipelago. All seem to present more or less indications of degeneracy from a higher state of culture, due probably to long isolation in this unfavourable environment since its separation in early quaternary times from the mainland. That it was inhabited by the ancestors of the Yahgans and Alaculufs even before the opening of Magellan Strait, appears evident, especially from the numerous kitchen-middens, some of vast size and great antiquity, scattered over the archipelago. Those of Elizabeth Island, by far the largest, the oldest, and in every respect the most interesting, run in one direction a distance of nearly a mile to a deep barranca, or ravine, beyond which they again stretch away for an interminable length along the coast. They stand at an elevation of from twenty to twenty-five feet above the present sea-level, and consist of a lower stratum of shells, bones, and other refuse, succeeded by a layer of fine sea-sand forty-five to fifty inches thick, above which comes an accumulation of rich vegetable humus overgrown with an abundant herbaceous vegetation. Whether the layer of sea-sand has been washed up or was deposited during a temporary subsidence of the land cannot be determined without further research. But in either case its presence bespeaks a vast antiquity for the lower stratum of refuse, which has an average depth of over three feet, and which contains the shells of *Mytilus pata*

gonicus, of *Aulacomya magellanica*, of *Patella magellanica*, fragments of *Otaria jubati*, and a few other mammals, but no human remains, no traces of pottery, no bones split for the extraction of the marrow, no arms or manufactured objects beyond a few rude spear- or arrow-heads. All this offers the most striking analogy to the more recent and modern refuse heaps now being formed, and seems to point at a continuity of population since early quaternary times. The absence of human remains or split bones might even imply that the primitive inhabitants, like their present descendants, were at no period addicted to anthropophagy. In other respects the latter occupy an extremely low social position. They practise no arts beyond the manufacture of frail bark canoes, unchanged since the time of Drake's visit, shell knives, bows, darts, and harpoons. The wigwams are branches stuck in the ground and gathered to a point above, or else a mere guanaco skin (among the Onas) suspended from a tree to windward. Their food is mainly fish, crustaceans, wild berries, mushrooms, cetaceans, greedily devoured in a highly putrescent state. They believe in ghosts and demons, but have no idea of a god, or of any religious worship; are guided rather by instincts than by reason; lack even the maternal sentiment, at least after the period of weaning; show no feeling of real affection for friends or kindred, the only developed sentiment being that of pure selfishness. Their stupidity is such that they are unable to count beyond three, after which everything is *vuru*—much, many. Yet, in the face of all this the writer was assured by the English missionaries now evangelising these primitive or debased peoples, that the language of the Yahgans, into which they have translated the Gospel of St. Luke, contains no less than 30,000 words, "a wealth contrasting strangely with their present low state of culture, and naturally suggesting the hypothesis of an origin very different and far superior to the present." But, assuming a former higher state, the difficulty is to understand how such a rich linguistic inheritance could have been preserved for countless generations in their present degraded condition, and amid the adverse surroundings of their present habitat. On this subject clearly more light is demanded.

CHARACTERISTICS OF THE NORTH AMERICAN FLORA[1]

II.

THIS contrast is susceptible of explanation. I have ventured to regard the two antipodal floras thus compared as the favoured heirs of the ante-Glacial high northern flora, or rather as the heirs who have retained most of their inheritance. For, inasmuch as the present Arctic flora is essentially the same round the world, and the Tertiary fossil plants entombed in the strata beneath are also largely identical in all the longitudes, we may well infer that the ancestors of the present northern temperate plants were as widely distributed throughout their northern home. In their enforced migration southward, geographical configuration and climatic differences would begin to operate Perhaps the way into Europe was less open than into the lower latitudes of America and Eastern Asia, although there is reason to think that Greenland was joined to Scandinavia. However that be, we know that Europe was fairly well furnished with many of the vegetable types that are now absent, possibly with most of them. Those that have been recognised are mainly trees and shrubs, which somehow take most readily to fossilisation, but the herbaceous vegetation probably accompanied the arboreal. At any rate, Europe then possessed Torreyas and Gingkos, Taxodium and Glyptostrobus, Libocedrus, Pines of our five-leaved type, as well as the analogues of other American forms, several species of Juglans answering to the American forms, and the now peculiarly American genus Carya, Oaks of the American types, Myricas of the two American types, one or two Planer-trees, species of Populus answering to our Cotton-woods and our Balsam-poplar, a Sassafras, and the analogues of our Persea and Benzoin, a Catalpa, Magnolias, and a Liriodendron, Maples answering to ours, and also a Negundo, and such peculiarly American Leguminous genera as the Locust, Honey Locust, and Gymnocladus. To understand how Europe came to lose these elements of her flora, and Atlantic North America to retain them, we must recall the poverty of Europe in native forest trees, to which I have already alluded. A few years ago, in an article on this subject, I drew up a sketch of the relative richness of Europe, Atlantic North America, Pacific North America, and the eastern side of temperate Asia in genera and species of forest trees (*Am. Journ. Sci.* iii. vi. 85). In that sketch, as I am now convinced, the European forest elements were somewhat under-rated. I allowed only 33 genera and 85 species, while to our Atlantic American forest were assigned 66 genera and 155 species. I find from Nyman's Conspectus that there are trees on the southern and eastern borders of Europe which I had omitted, that there are good species which I had reckoned as synonyms, and some that may rise to arboreal height which I had counted as shrubs. But on the other hand and for the present purpose it may be rejoined that the list contained several trees, of as many genera, which were probably carried from Asia into Europe by the hand of man. On Nyman's authority I may put into this category *Cercis Siliquastrum*, *Ceratonia Siliqua*, *Diospyros Lotus*, *Styrax officinalis*, the Olive, and even the Walnut, the Chestnut, and the Cypress. However this may be, it seems clear that the native forest flora of Europe is exceptionally poor, and that it has lost many species and types which once belonged to it. We must suppose that the herbaceous flora has suffered in the same way. I have endeavoured to show how this has naturally come about. I cannot state it more concisely than in the terms which I used six years ago.

"I conceive that three things have conspired to this loss of American, or as we might say, of normal types sustained by Europe. First, Europe, extending but little south of lat. 40°, is all within the limits of severe glacial action. Second, its mountains trend east and west, from the Pyrenees to the Carpathians and the Caucasus beyond; they had glaciers of their own, which must have begun their work and poured down the northward flanks while the plains were still covered with forest on the retreat from the great ice forces coming from the north. Attacked both on front and rear, much of the forest must have perished then and there.

"Third, across the line of retreat of whatever trees may have flanked the mountain ranges, or were stationed south of them, stretched the Mediterranean, an impassable barrier. . . . Escape by the east, and rehabilitation from that quarter until a very late period, was apparently prevented by the prolongation of the Mediterranean to the Caspian, and probably thence to the Siberian Ocean. If we accept the supposition of Nordenskjöld that, anterior to the Glacial period, Europe was 'bounded on the south by an ocean extending from the Atlantic over the present deserts of Sahara and Central Asia to the Pacific,' all chance of these American types having escaped from and re-entered Europe from the south and east seems excluded. Europe may thus be conceived to have been for a time somewhat in the condition in which Greenland is now. . . . Greenland may be referred to as a country which, having undergone extreme glaciation, bears the marks of it in the extreme poverty of its flora, and in the absence of the plants to which its southern portion, extending six degrees below the Arctic circle, might be entitled. It ought to have trees and it might support them. But since their destruction by glaciation no way has been open for their return. Europe fared much better, but has suffered in its degree in a similar way" (*American Journal of Science*, *l.c.*, p. 194).

Turning to this country for a contrast, we find the continent on the eastern side unbroken and open from the Arctic circle to the tropic, and the mountains running north and south. The vegetation when pressed on the north by on-coming refrigeration had only to move its southern border southward to enjoy its normal climate over a favourable region of great extent; and, upon the recession of glaciation to the present limit, or in the oscillations which intervened, there was no physical impediment to the adjustment. Then, too, the more southern latitude of this country gave great advantage over Europe. The line of terminal moraines, which marks the limit of glaciation, rarely passes the parallel of 40° or 39°. Nor have any violent changes occurred here, as they have on the Pacific side of the continent, within the period under question. So, while Europe was suffering hardship, the lines of our Atlantic American flora were cast in pleasant places, and the goodly heritage remains essentially unimpaired.

The transverse direction and the massiveness of the mountains of Europe, while they have in part determined the comparative poverty of its forest vegetation, have preserved there a rich and widely distributed Alpine flora. That of Atlantic North America

[1] An Address to the Botanists of the British Association for the Advancement of Science; read at Montreal to the Biological Section, August 29, 1884, by Prof Asa Gray. Continued from p. 235.

is insignificant. It consists of a few Arctic plants left scattered upon narrow and scattered mountain-tops, or in cool ravines of moderate elevation; the maximum altitude is only about 6000 feet in lat. 44°, on the White Mountains of New Hampshire, where no winter snow outlasts midsummer. The best Alpine stations are within easy reach of Montreal. But as almost every species is common to Europe, and the mountains are not magnificent, they offer no great attraction to a European botanist.

Farther south, the Appalachian Mountains are higher, between lat. 36° and 34° rising considerably above 6000 feet; they have botanical attractions of their own, but they have no Alpine plants. A few sub-Alpine species linger on the cool shores of Lake Superior at a comparatively low level. Perhaps as many are found nearly at the level of the sea on Anticosti, in the Gulf of St. Lawrence, abnormally cooled by the Labrador current.

The chain of great fresh-water lakes, which are discharged by the brimming St. Lawrence, seems to have little effect upon our botany, beyond the bringing down of a few north-western species. But you may note with interest that they harbour sundry maritime species, mementos of the former saltness of these interior seas. *Cakile Americana*, much like the European Sea Rocket, *Hudsonia tomentosa* (a peculiar Cistaceous genus imitating a Heath), *Lathyrus maritimus*, and *Ammophila arenaria* are the principal. Salicornia, Glaux, *Scirpus maritimus*, *Ranunculus Cymbalaria*, and some others may be associated with them. But these are widely diffused over the saline soil which characterises the plains beyond our wooded region.

I have thought that some general considerations like these might have more interest for thei Biological Section at large than any particular indications of our most interesting plants, and of how and where the botanist might find them. Those who in these busy days can find time to herborise will be in the excellent hands of the Canadian botanists. At Philadelphia their brethren of "the States" will be assembled to meet their visitors, and the Philadelphians will escort them to their classic ground, the Pine Barrens of New Jersey. To have an idea of this peculiar phytogeographical district, you may suppose a long wedge of the Carolina coast to be thrust up northward quite to New York harbour, bringing into a comparatively cool climate many of the interesting low-country plants of the south, which at this season you would not care to seek in their sultry proper home. Years ago, when Pursh and Leconte and Torrey used to visit it, and in my own younger days, it was wholly primitive and unspoiled. Now, when the shore is lined with huge summer hotels, the Pitch Pines carried off for firewood, the bogs converted into cranberry-grounds, and much of the light sandy or gravelly soil planted with vineyards or converted into melon and sweet-potato patches, I fear it may have lost some of its botanical attractions. But large tracts are still nearly in a state of nature. *Drosera filiformis*, so unlike any European species, and the beautiful Sabbatias, the yellow Fringed Orchises, Lachnanthes and Lophiola, the larger Xyrises and Eriocaulons, the curious grass Amphicarpum with cleistogamous flowers at the root, the showy species of Chrysopsis, and many others. must still abound. And every botanist will wish to collect *Schizæa pusilla*, rarest, most local, and among the smallest of ferns.

If only the season would allow it, there is a more southern station of special interest,—Wilmington, on the coast of North Carolina. Carnivorous plants have, of late years, excited the greatest interest, both popular and scientific, and here, of all places, carnivorous plants seem to have their most varied development. For this is the only and the very local home of Dionæa; here grow almost all the North American species of Drosera; here or near by are most of the species of Sarracenia, of the bladder-bearing Utricularias—one of which the President of our Section has detected in fish-catching—and also the largest species of Pinguicula.

But at this season a more enjoyable excursion may be made to the southern portion of the Alleghany or Appalachian Mountains, which separate the waters of the Atlantic side from those of the Mississippi. These mountains are now easily reached from Philadelphia In Pennsylvania, where they consist of parallel ridges without peaks or crests, and are of no great height, they are less interesting botanically than in Virginia; but it is in North Carolina and the adjacent borders of Tennessee that they rise to their highest altitude, and take on more picturesque forms. On their sides the Atlantic forest, especially its deciduous-leaved portion, is still to be seen to greatest advantage, nearly in pristine condition, and composed of a greater variety of genera and species than in any other temperate region, excepting Japan. And in their shade are the greatest variety and abundance of shrubs, and a good share of the most peculiar herbaceous genera. This is the special home of our Rhododendrons, Azaleas, and Kalmias; at least, here they flourish in greatest number and in most luxuriant growth. *Rhododendron maximum* (which is found in a scattered way even as far north as the vicinity of Montreal) and *Kalmia latifolia* (both called Laurels) even become forest trees in some places; more commonly they are shrubs, forming dense thickets on steep mountain-sides, through which the traveller can make his way only by following old bear-paths, or by keeping strictly on the dividing crests of the leading ridges.

Only on the summits do we find *Rhododendron Catawbiense*, parent of so many handsome forms in English grounds, and on the higher wooded slopes the yellow and the flame-coloured *Azalea calendulacea*; on the lower the pink *A. nudiflora* and more showy *A. arborescens*, along with the common and widespread *A. viscosa*. The latter part of June is the proper time to explore this region, and, if only one portion can be visited, Roan Mountain should be preferred.

On these mountain-tops we meet with a curious anomaly in geographical distribution. With rarest exceptions, plants which are common to this country and to Europe extend well northward But on these summits from Southern Virginia to Carolina, yet nowhere else, we find—undoubtedly indigenous and undoubtedly identical with the European species—the Lily-of-the-Valley!

I have given so much of my time to the botany of the Atlantic border that I can barely touch upon that of the western regions.

Between the wooded country of the Atlantic side of the continent and that of the Pacific side lies a vast extent of plains which are essentially woodless, except where they are traversed by mountain-chains. The prairies of the Atlantic States bordering the Mississippi and of the Winnipeg country shade off into the drier and gradually more saline plains, which, with an even and gradual rise, attain an elevation of 5000 feet or more where they abut against the Rocky Mountains. Until these are reached (over a space from the Alleghanies westward of about twenty degrees of longitude) the plains are unbroken. To a moderate distance beyond the Mississippi the country must have been in the main naturally wooded. There is rainfall enough for forest on these actual prairies. Trees grow fairly well when planted; they are coming up spontaneously under present opportunities; and there is reason for thinking that all the prairies east of the Mississippi, and of the Missouri up to Minnesota, have been either greatly extended or were even made treeless under Indian occupation and annual burnings. These prairies are flowery with a good number of characteristic plants, many of them evidently derived from the plains farther west. At this season the predominant vegetation is of Compositæ, especially of Asters and Solidagoes, and of Sunflowers, Silphiums, and other Helianthoid Compositæ

The drier and barer plains beyond, clothed with the short Buffalo-Grasses, probably never bore trees in their present state, except as now some Cotton-woods (*i.e.* Poplars) on the margins of the long rivers which traverse them in their course from the Rocky Mountains to the Mississippi. Westward the plains grow more and more saline; and Wormwoods and Chenopodiaceæ of various sorts form the dominant vegetation, some of them *sui generis*, or at least peculiar to the country, others identical or congeneric with those of the steppes of Northern Asia. Along with this common campestrine vegetation there is a large infusion of peculiar American types, which I suppose came from the southward, and to which I will again refer.

Then come the Rocky Mountains, traversing the whole continent from north to south; their flanks wooded, but not richly so,—chiefly with Pines and Firs of very few species, and with a single ubiquitous Poplar, their higher crests bearing a well-developed Alpine flora. This is the Arctic flora prolonged southward upon the mountains of sufficient elevation, with a certain admixture in the lower latitudes of types pertaining to the lower vicinity.

There are almost 200 Alpine Phænogamous species now known on the Rocky Mountains, fully three-quarters of which are Arctic. including Alaskan and Greenlandian; and about half of them are known in Europe. Several others are North Asian, but not European. Even in that northern portion of

the Rocky Mountains which the Association is invited to visit, several Alpine species novel to European botany may be met with; and farther south the peculiar forms increase. On the other hand, it is interesting to note how many Old World species extend their range southward even to lat. 36° or 35°.

I have not seen the Rocky Mountains in the Dominion; but I apprehend that the aspect and character of the forest is Canadian, is mainly coniferous, and composed of very few species. Oaks and other cupuliferous trees, which give character to the Atlantic forest, are entirely wanting, until the southern confines of the region are reached in Colorado and New Mexico, and there they are few and small. In these southern parts there is a lesser amount of forest, but a much greater diversity of genera and species, of which the most notable are the Pines of the Mexican plateau type.

The Rocky Mountains and the Coast Ranges on the Pacific side so nearly approach in British America that their forests merge, and the eastern types are gradually replaced by the more peculiar western. But in the United States a broad, arid, and treeless, and even truly desert region is interposed. This has its greatest breadth and is best known where it is traversed by the Central Pacific Railroad. It is an immense plain between the Rocky Mountains and the Sierra Nevada, largely a basin with no outlet to the sea, covered with Sage-brush (*i.e.* peculiar species of Artemisia) and other subsaline vegetation, all of grayish hue; traversed, mostly north and south, by chains of mountains, which seem to be more bare than the plains, but which hold in their recesses a considerable amount of forest and of other vegetation, mostly of Rocky Mountain types.

Desolate and desert as this region appears, it is far from uninteresting to the botanist; but I must not stop to show how. Yet even the ardent botanist feels a sense of relief and exultation when, as he reaches the Sierra Nevada, he passes abruptly into perhaps the noblest coniferous forest in the world—a forest which stretches along this range and its northern continuation, and along the less elevated ranges which border the Pacific coast, from the southern part of California to Alaska.

So much has been said about this forest, about the two gigantic trees which have made it famous, and its Pines and Firs which are hardly less wonderful, and which in Oregon and British Columbia, descending into the plains, yield far more timber to the acre than can be found anywhere else, and I have myself discoursed upon the subject so largely on former occasions, that I may cut short all discourse upon the Pacific coast flora and the questions it brings up.

I note only these points. Although this flora is richer than that of the Atlantic in Coniferæ (having almost twice as many species), richer indeed than any other except that of Eastern Asia, it is very meagre in deciduous trees. It has a fair number of Oaks, indeed, and it has a Flowering Dogwood, even more showy than that which brightens our eastern woodlands in spring. But altogether it possesses only one-quarter of the number of species of deciduous trees that the Atlantic forest has; it is even much poorer than Europe in this respect. It is destitute not only of the characteristic trees of the Atlantic side, such as Liriodendron, Magnolia, Asimina, Nyssa, Catalpa, Sassafras, Carya, and the arboreous Leguminosæ (Cercis excepted), but it also wants most of the genera which are common throughout all the other northern temperate floras, having no Lindens, Elms, Mulberries, Celtis, Beech, Chestnut, Hornbeam, and few and small Ashes and Maples. The shrubbery and herbaceous vegetation, although rich and varied, is largely peculiar, especially at the south. At the north we find a fair number of species identical with the eastern; but it is interesting to remark that this region, interposed between the North-East Asiatic and the North-East American and with coast approximate to the former, has few of those peculiar genera which, as I have insisted, witness to a most remarkable connection between two floras so widely sundered geographically. Some of these types, indeed, occur in the intermediate region, rendering the general absence the more noteworthy. And certain peculiar types are represented in single identical species on the coasts of Oregon and Japan, &c. (such as Lysichiton, Fatsia, Glehnia); yet there is less community between these floras than might be expected from their geographical proximity at the north. Of course the high northern flora is not here in view.

Now if, as I have maintained, the eastern side of North America and the eastern side of Northern Asia are the favoured heirs of the old boreal flora, and if I have plausibly explained how Europe lost so much of its portion of a common inheritance, it only remains to consider how the western side of North America lost so much more. For that the missing types once existed there, as well as in Europe, has already been indicated in the few fossil explorations that have been made. They have brought to light Magnolias, Elm, Beeches, Chestnut, a Liquidambar, &c. And living witnesses remain in the two Sequoias of California, whose ancestors, along with Taxodium, which is similarly preserved on the Atlantic side, appear to have formed no small part of the Miocene flora of the Arctic regions.

Several causes may have conspired in the destruction;—climatic differences between the two sides of the continent, such as must early have been established (and we know that a difference no greater than the present would be effective); geographical configuration, probably confining the migration to and fro to a long and narrow tract, little wider, perhaps, than that to which it is now restricted; the tremendous outpouring of lava and volcanic ashes just anterior to the Glacial period, by which a large part of the region was thickly covered; and, at length, competition from the Mexican plateau vegetation,—a vegetation beyond the reach of general glacial movement from the north, and climatically well adapted to the south-western portion of the United States.

It is now becoming obvious that the Mexican plateau vegetation is the proximate source of most of the peculiar elements of the Californian flora, as also of the southern Rocky Mountain region and of the Great Basin between; and that these plants from the south have competed with those from the north on the eastward plains and prairies. It is from this source that are derived not only our Cacteæ but our Mimoseæ, our Daleas and Petalostemons, our numerous and varied Onagraceæ, our Loasaceæ, a large part of our Compositæ, especially the Eupatoriaceæ, Helianthoideæ, Helenioideæ, and Mutisiaceæ, which are so characteristic of the country, the Asclepiadeæ, the very numerous Polemoniaceæ, Hydrophyllaceæ, Eriogoneæ, and the like.

I had formerly recognised this element in our North American flora, but I have only recently come to apprehend its full significance. With increasing knowledge we may in a good measure discriminate between the descendants of the ancient northern flora and those which come from the highlands of the south-west.

BRYN MAWR COLLEGE

THIS College is an Institution for Women, founded by the late Dr. Joseph W. Taylor; the following account of its foundation and objects, from the *Philadelphia Ledger*, has been kindly forwarded to us by Prof. Sylvester.

The work on the buildings and other preparations for the opening of the College are being pushed forward as expeditiously as possible, so that everything will be ready by June next. This new educational institution, it will be remembered, was founded by the late Joseph W. Taylor, M.D., a prominent member of the Society of Friends, of Burlington, N.J., who bought the land—about thirty-two acres—and began the erection of the college buildings in 1879. He died in January, 1880, leaving an endowment of 800,000 dols. for the continuance of the work he had begun—the erection and starting of a college for women.

By the terms of the will of the founder, the Trustees are members of the Society of Friends, but the students may be of any denomination, and their religious belief is to be respected. It was part of the purpose of Dr. Taylor to give to women of intelligence and refinement the best opportunities for culture, combined with Christian influences and social amenities. Scholars under sixteen years will be ineligible for admission. The Board of Trustees consists of: President—Francis T. King, of Baltimore, Md.; Charles S. Taylor, Burlington, N.J.; James C. Thomas, Baltimore, Md.; James E. Rhoades, Philadelphia; James Whitall, Philadelphia; John B Garrett, Bryn Mawr, Penn.; Charles Harteshorne, Philadelphia; David Scull, Jr., Philadelphia; William R. Thurston, New York City; Albert K. Smiley, Lake Mohonk, N.Y.; Francis R. Cope, Philadelphia; Philip C. Garrett, Philadelphia, and Edward Bittle, Philadelphia.

As Dr. Taylor did not wish the college named after him, the Trustees have given the title of Taylor Hall to the main building, in commemoration of his munificent bequest. This building,

according to the plans, will contain rooms for chemical, biological, and botanical laboratories, a library and reading room, a handsome assembly room, and recitation rooms. It will be 130 feet long, three stories in height, and constructed of Port Deposit granite stone. Work on it was begun in August, 1879.

The second building, Merion Hall, contains the dormitories. It is built of Fairmount stone, three stories high, and will be 160 feet long, affording accommodation for fifty students and caretakers. The study rooms are to be so arranged that two of the pupils will use one in common, each pupil having a bedroom on either side of the study room. The latter apartments will each have an open fireplace, but the building will be warmed by air heated by steam, and carried through the house under slight pressure from a fan. All rooms occupied by the students are to be ventilated by a main shaft which acts as a chimney for the boiler house, so that a constant current of warm air reaches the rooms, while at the same time the vitiated air is withdrawn. All the bathing and plumbing arrangements have been placed in one wing, constructed with great care, and are ventilated by force ventilation. The dining-room entrance, hall and parlour, are to be appropriately fitted up.

For the gymnasium the plans provide a brick building, 80 by 74 feet. It will contain a main hall, supplied with the most perfect appliances in use by Dr. Sargent at Harvard College, offices, dressing-room, baths, and an examination room, in which a record of the exercises will be kept. A track, raised nine feet from the floor, and extending around the building on the inside, will also be provided, in order to permit the students to run or walk when inclement weather prevents out-door exercise. The gymnasium will be under the charge of a lady trained by Dr. Sargent, who will be the instructress in light gymnastics. Under her direction all exercises will be carefully regulated to the strength of the students, to insure normal development and avoid all danger of over-exertion.

The laundry will contain the boilers which will furnish heat and hot water to the other buildings, in addition to the necessary appliances of a laundry. A house is being built on the adjoining lot for the President, and three cottages which are already on the premises are to be used for the Faculty or to accommodate any overflow of students from Merion Hall until other permanent structures like it are built. The plan adopted contemplates four such structures, to hold 160 students. The total cost of the buildings, including construction and furnishing of laboratories, providing for heating and water supply, the purchase, grading, and ornamenting the grounds, a complete system of drainage on the Waring system, and furniture, will probably exceed 200,000 dols.

It is understood that a large number of applications have already been received by the trustees, and many students whose names have not yet been recorded are known to be preparing. The college will be one of strictly high grade, and will have no preparatory department. The "group system" of arranging studies in the college course, which is adopted, to some extent, in England, but most perfectly represented in the Johns Hopkins University at Baltimore, is to be used. It secures to the students, it is claimed, a thorough training in the two chief ancient and the modern languages, in mathematics, and in some branches of science, besides instruction in metaphysics, drawing, hygiene, and art.

Each department will be under the instruction of specialists, and all students will be required to pursue certain prescribed studies. There will be five fellowships to college graduates who have already distinguished themselves in particular branches of study, namely: Greek, English, mathematics, history, and biology. A scholarship of 500 dols. will be offered yearly to a graduate of Bryn Mawr College to enable her to pursue studies in some European university.

The Trustees, knowing the large expense necessary to procure the best professors, a good library, and a supply of all laboratory appliances required for a college of the best class, have husbanded the funds placed in their hands for the future use of the institution, and it is said but little of the endowment will have been encroached upon before the college opens. Although some of the Trustees are also managers of Haverford College, "Bryn Mawr" will be an independent institution, and practically a Philadelphia one.

The Faculty has not yet been perfected, but the Trustees have made the following selections:—Dean of the Faculty and Professor of English, M. Carey Thomas, Ph.D., University of Zürich; Associate in Botany, Emily L. Gregory, L.B., late in charge of the laboratory work of Harvard Annex, and Teacher of Botany in Smith College; Associate Professor of Biology, Edmund B. Wilson, Ph.D., Fellow in Biology of Johns Hopkins University, and late Lecturer on Biology in Williams College, and Associate Professor of Mathematics; Charlotte Angus Scott, A.B., Sc.B., University of London, and late Lecturer on Mathematics in Girton and Newnham Colleges. It is expected that all the chief appointments will have been made before the appearance of the college catalogue.

Dr James E. Rhoades, the President of the college, in speaking of women's colleges a few days since, said: "New England has from an early date given great attention to collegiate education, and has at the present time three colleges for women, beside the Harvard Annex. The States south of New England and west of Pennsylvania need a college to give the desired facilities for higher education to the graduates of girls' schools and high schools. A large part of the teaching in the United States is done by women, who, not having the advantages of men, are obliged to take lower and less remunerative positions."

SCIENTIFIC SERIALS

The American Journal of Science, December 1884.—The distribution and origin of Drumlins, by W. M. Davis. The term drumlin is here taken in a generic sense to include any kind of more or less smoothly-rounded hills formed by local accumulation of glacial drift on a foundation of different geological formation. The subject is treated under five heads:—(1) the place of drumlins in a geographical classification; (2) terminology: (3) general description; (4) distribution; (5) origin.—The geological relations and genesis of the specular iron ores occurring in the Sierra Maestra (Coast Range) of the district of Santiago de Cuba, by James P. Kimball.—A new tantalite locality, by Charles A. Schaeffer. The author describes a mineral from the Etta tin mine, Dakotah, hitherto supposed to be casiterite, but which is shown to be tantalite. The analysis gave the following results:—

Tantalic oxide	79·01
Stannic oxide	0·39
Ferrous oxide	8·33
Manganous oxide	12·13
	99·86

—Note on Palæozoic rocks of Central Texas, by Charles D. Walcott. The results are given of a recent survey of a portion of the Palæozoic area in this region, undertaken chiefly for the purpose of studying the Cambrian section and collecting fossils from the Texas Potsdam horizon. Besides procuring fresh data on the Potsdam and Silurian sections and faunas, the author determined the true relations of an area hitherto known as Archæan, but which is now referred to the Cambrian. The age of the granite of Barnet County was also determined.—On the sufficiency of terrestrial rotation for the defection of streams, by A. C. Baines.—Chemical affinity; part iii., the existing problem, by John W. Langley.—Peculiar modes of occurrence of gold in Brazil, by Orville A. Derby. A specimen in the National Museum, Rio de Janeiro, from Ponte Grande, Minas Geraes, shows films of gold on limonite, which the author thinks can scarcely be accounted for except on the hypothesis of natural deposition from solution. The districts of Campanha and S. Gonçalo in the same province afford examples of large auriferous deposits in decomposed gneiss with an almost complete absence of veins and of the other usual concomitants of gold.—On colemanite, a new borate of lime, by A. Wendell Jackson. This substance has recently been determined by J. T. Evans, whose analysis gives the formula:

$$2CaO . 3B_2O_2 . 5 \text{ aq.}$$

It differs from pandermite in containing five instead of three molecules of water, but its chief interest lies in its morphological relations.—On the decay of quartzite and the formation of sand, kaolin, and crystallised quartz, by James D. Dana.

Revue d'Anthropologie, tome viii. fasc. 4, 1884. Paris.—A continuation of M. Mathias Duval's lectures on "Transformism," dealing chiefly with the questions of natural selection and survival of the fittest.—Notes on the anatomy of two negroes, by Dr. T. Chudzinski, head of the anatomical department of the Faculty of Medicine at Paris.—On the "Beni-M'Zab," by Dr. Amat. The writer here gives the results of

personal observations made during his tenure in 1883 of a medical official post in the country of these tribes, who live under the French protectorate, and occupy an immense territory of Barbara, lying between 32° and 33° 20′ N. lat. and 0° 40′ and 1° 50′ E. long. After giving a summary of the principal historical events connected with this people, who lay claim to being the sole representatives of the pure Berbers in Algiers, Dr. Amat enters at great length into the consideration of the results obtained by his careful anthropometric examination of fifty natives of Ghardaia. From the means of these determinations it would appear that the M'Zabites are of generally lower stature, and have less delicately proportioned limbs and features than the Arabs, but that, like the latter, they are often perfectly white in infancy, while light-coloured hair and beards are occasionally met with among the adults. The people are under the government of a religious or teaching body, composed of a powerful caste of learned clerks, or *tolbas*. The practice of interring food and domestic utensils with the dead points to usages of more ancient date than those of the form of Islamism which they follow. Unlike the genuine Arabs, they migrate in large numbers to the cities, where they conduct prosperous mercantile businesses, while they are the great corn purveyors of the Sahara. They employ among themselves a special form of language, which is a Berber dialect with certain affinities to the Kabyle, and is not a written tongue. The form of Islamism followed is that known as Owahbite Ibadite.—The concluding part of M. Denicker's notes on the Kalmuks. The author here treats of the special form of Buddhist Lamaism followed by the Kalmuk tribes, their hierarchy, mythology, rituals, religious festivals, objects of worship, and the special forms under which Cakya, Mowni, and others of their most highly-venerated so-called *bourkans*, are worshipped. Owing to the comparatively late adoption of Buddhism, the Kalmuks have retained in their epic poems, aphorisms, and folk-lore, of which examples are given, more of the primitive Mongolian character than some of their kindred; but the Russian Kalmuks, like their brethren in China, are rapidly losing the warlike and aggressive spirit of their ancestors under the levelling systems of government to which they are subjected in both empires.—On the horizontal plane of the cranium, by E. Goldstein, with tables giving the variations and differences determined among persons of different races. These tables, which are remarkable for their voluminous and detailed character, will be found of great use in studying the causes of the angular variations observable in various ethic groups, and in the anthropoids, and in determining how far such deviations from a fixed horizontal line are dependent on race, age, or disease.

Bulletins de la Société d'Anthropologie de Paris, tome vii., fasc. 3, 1884.—M. de Ujfalvy's report of the results obtained by Dr. Lenhossek and others from an examination of the ancient Magyar tumuli, laid bare on the reconstruction of the town of Szegedin after the inundations of 1879.—On the age and character of the covered *allées* of dolmens on the plain of Ellez, near Tunis, by M. Girard de Rialle. The report is based on the communications of M. Poinssot.—On the presence of *Elephas primigenius* in the alluvial Chelles-beds, by M. Chouquet, who does not consider the juxtaposition of fossil remains as a proof of contemporaneity, but rather as the result of distinct depositions, which frequently belong to different geological periods.—Communication by M. D'Acy on the mammoth of the Cromer forest beds.—On the caves of Saumoussay, near Saumur, by M. Bonnemère, whose opinion that they are of pre-Roman date is opposed by M. Drouawlt and others.—On the exploration of the caves of Muikow in Cracovia, by M. Zaborowski. The authenticity of the supposed "finds" of Muikow is forcibly called in question by MM. Mortillet, Szambatty, and other local authorities.—Notes on the anthropological characters of California, by M. Ten Kate, who has here given the results of the cephalometric and other measurements made by him in his explorations, in 1883, of the districts of California south of 24° 40′ N. lat. The crania examined were of a well-marked Melanesian character, dolichocephalous, with moderate prognathism.—On a supplementary part of the great pectoral muscle, by M. Chudzinski.—On the influence of climate and race on the normal temperature of the human body, by Dr. Maurel. The results deduced from carefully tested determinations seem to be that the temperature of Europeans in intertropical and equatorial regions is raised only about 0° 30′ above its normal range in Europe, but that the mean temperature of certain races, as the Hindoos, is about 0° 50′ higher than that of Europeans.—On a gorilla fœtus, by M. Denicker. The subject was a female resembling in its pose and its thoracic development a human fœtus of five or six months. The lower members presented the true gorilla character.—On the antiquity of the Dingo in Australia, by M. Zabrowski.—On the case of a living double monstrosity, by M. Fourdrignier.—On cephalometric determinations of certain murderers who had been executed, as compared with measurements yielded by an equal number of persons distinguished for excellence of character or attainments, by Dr. Bajenoff.—On the first rudiments of infantine speech, by Dr. Allaire. The author considers that six distinct periods are observable in the development of the powers of speech, which are dependent on the successive processes of suction, digestion, dentition, &c., labial sounds being first emitted, while the dentals are acquired after the gutturals and nasals.—On recent German views regarding the cradle of the Aryan races, by M. Ujfalvy.—On the depopulation of the Marquisas, by M. Clavel, who considers that the general change of habits, and the cessation of intertribal wars, with its attendant decrease of activity, which have resulted from their contact with Europeans, must, rather than alcoholism of which he has seen no genuine cases, be accepted as the real factors in the rapid diminution of population that is going on in the Polynesian archipelago.—Note on the chariots of war employed by the Gauls, by M. Pétriment.—On the significance of the annual festival of the Indian Arikaris of Dokata, by Dr. Hoffman.—On the pathological characteristics of the Mandinguis of the Ouolof country, by Dr. Tautain.—On the "*Couvade*," by Dr. Maurel. The writer, on the authority of Dr. Lenoël of Amiens, asserts that this usage exists at the present day among the Indians of Guyana, near the Amazon.

Reale Istituto Lombardo, November 13, 1884.—The paintings of the Italian masters in the public museums of Europe, by Prof. G. Mongeri.—On the projected Penal Code for Italy, by Prof. A. Buccellati.—On the secular variation of the elements of terrestrial magnetism at Milan, by Ciro Chistoni.—On the total eclipse of the moon, October 4, 1884, by Prof. G. Celoria.—Meteorological observations made at the Brera Observatory, Milan, during the months of August and September, 1884.

November 27.—Experimental studies on the antiseptics of tubercular virus, by Prof. G. Sormani and Dr. E. Brugnatelli.—Successful treatment of a large tumour of twenty-two years' standing in the left side of a patient forty years of age, by Dr. G. Fiorani.—On the geometrical movement of the invariable systems, by Prof. C. Formenti.—The paintings of the Italian masters in the public museums of Europe (continued), by Prof. G. Mongeri.—Meteorological observations made at the Brera Observatory during the month of October 1884.

Jahrbücher für wissenschaftliche Botanik, herausgegeben von Dr. N. Pringsheim, Band xiii., Viertes Heft.—"Beiträge zür Morphologie und Physiologie der Meeresalgen," by G. Berthold, contains detailed investigations of the heliotropism of marine Algæ; also of the influence of other factors upon their structure and mode of growth, together with a description of certain means by which marine Algæ protect themselves from too great intensity of light, *e.g.* (1) by hair-like organs, of which the author distinguishes three types; (2) by peculiar formations in the protoplasm of individual cells: the most highly developed structures of this order are found in the genus *Chylocladia*, where one is to be seen in each of the peripheral cells of the thallus, and appears as a highly refractive, plate-like mass in close apposition with the outer wall. Reactions show that these structures consist chiefly of a substance of a proteid nature.—"Ueber die Wasservertheilung in heliotropisch gekrummten Pflanzentheilen," by A. Thate. The author tests Kraus's view that in organs with positively heliotropic curvature the shaded side contains more water than the illuminated side; he concludes that such a difference in amount of water cannot be proved, though on the other hand it cannot be asserted that it does not exist, analytical methods being as yet too imperfect: at best only approximate results can be obtained by Kraus's method.

Band xiv., Erstes Heft.—"Beiträge zur Entwickelungsgeschichte einiger Inflorescenzen," by K. Göbel. This article is chiefly devoted to the study of the development of the inflorescence in the *Gramineæ*. The author finds that, as regards their symmetry, the different varieties of inflorescence in this order cannot be referred to one type, but to two, the dorsiventral and the radial.—"Ueber Bau und Funktion des pflanzlichen Hautgewebesystems," by M. Westermaier, suggests as an important function of the epidermis that it shares with the vascular

system in the supply of water to the internal tissues, forming a complete peripheral mantle of aqueous tissue.—"Ueber Poren in den Aussenwänden von Epidermiszellen," by H. Ambronn. An attempt to show that the origin of pits in the outer walls of epidermal cells is referable to undulations in the young walls, and that these pits are not to be regarded as the functional equivalents of those in the walls of internal tissues.—"Nachträgliche Bemerkungen zu den Befruchtungsact von Achlya," by N. Pringsheim. A further contribution to the controversy as to the sexuality of the Saprolegniæ.

Zweites Heft.—"Ueber das Vorkommen von Gypskrystallen bei den Desmidieen," by Alfred Fischer. An investigation of the crystals of Calcium sulphate already known to exist in *Closterium*; similar bodies are also found in other genera of Desmids. In *Staurastrum*, *Desmidium*, and *Hyalotheca* they are not found. The author concludes that they are to be regarded as an excretory product; when the quantity produced is small, it may remain dissolved in the cell-sap; when larger it appears as crystals.—"Ueber farbige körnige Stoffe des Zellinhalts," by P. Fritsch. This article deals with the "anatomical structure" of colouring granules, exclusive of chlorophyll, and without reference to their development. In the light of recent discoveries the chief interest of such bodies centres in their development, and their relation to the chlorophyll granules.—"Die Zellhaut, und das Gesetz der Zelltheilungsfolge von Melosira (Orthosira Thwaites) Arenaria Moore," by Otto Müller. A careful investigation of the succession of divisions as seen in this filamentous Diatom, which will throw light upon the process of multiplication of cells in other members of the group.

Drittes Heft.—"Untersuchungen über die Homologien der generativen Produkte der Fruchtblätter bei den Phanerogamen und Gefässkryptogamen," by L. Celakovsky. The author brings evidence from teratological specimens to bear upon the question of the homology of the integuments of the ovule with the indusium of the Fern-Sorus, with the object of establishing that homology.—"Untersuchungen über die Morphologie und Anatomie der Monokotylen-ähnlichen Eryngien," by M. Möbius. The main results of this investigation are that the similarity of the parallel-nerved species of Eryngium to the Monocotyledons lies only in the leaves and rhizomes; that it extends, however, beyond mere external characters, and may be recognised in the anatomical structure.

Bulletin de la Société des Naturalistes de Moscow, 1884, No. 1.—On the calculation of the average figures of relative wetness, by K. Weihrauch (in German). The author shows that the averages calculated by a mere addition of the observed values of $\frac{s}{k}$ do not give correct figures, and advocates a calculation consisting of an addition of all numerators (s) and of all denominators (k) separately, before making the division. He illustrates his method by several examples taken from the series of observations in the Caucasus. The paper will be continued.—What becomes of bile in the digestive tube? by Dr. A. Weiss (in French). The author confirms to some extent the well-known opinion of Prof. Schiff.—Materials for the flora of the Government of Tamboff, district of Tamboff, by Th. Ignatieff. The steppe flora is characterised, as usual, by the *Stipa pennata*, but the following plants, showing a passage towards a more southern flora, are met with:—*Adonis vernalis*, *Verbascum Phœniceum*, *Echium rubrum*, *Muscari leucophæum*, *Iris furcata*, *Fritillaria ruthenica*, and *Salvia nutans*. All these, which do not extend much north—they are not met with in the Moscow flora—are remarkable for the most vivid coloration of their flowers. The author gives a list of 464 plants found at Exthal.—Review of the generative organs of the males of Bombus, by General Radoszkowski (in French), with four plates.—Short description of a journey to Central Asia, lecture by N. Sorokine (in French). The author adds to his paper a very interesting chromolithographed picture representing a *saksaoul* forest (*Akabasis ammodendron*, Ledebour) of the Kyzyl-kounis deserts. It is for the first time that we find in print so good a representation of this plant as it covers the *bar-khans*, or sandy downs, of the Steppe.—Researches into the histology of the hair, the bristle, the prickle, and the pen, by W. Lwoff (in German), with four plates.—Notice on the hypotheses as to the origin of Lake Baikal, by W. Dybowsky (in German). The recent discovery in Lake Baikal of the very same sponge (*Lubomirskia baicalensis*) which is met with in the Bering Sea leads to the conclusion that it has immigrated into Lake Baikal from this sea. On the other side, several explorers of Siberia, and recently again M. Cherski, have shown that there are no traces of a marine communication of Lake Baikal with the sea during and since the post-Pliocene period; but there are very numerous traces of large lakes connected formerly by broad rivers, and it would seem probable that the sponge might have immigrated by this way. Dr. Dybowsky leaves the question open.

Bulletin de l'Académie Royale de Belgique, November 8, 1884.—On certain phenomena of reduction produced in grains when germinating, and on the formation of diastase, by M. A. Jorissen.—On the quadrilinear form and surfaces of the third order, by Prof. C. Le Paige.—Verbal communication on the phenomenon of stellar scintillation, by Ch. Montigny.—On the advanced vegetation observed in the spring of 1884 at Longchamps-sur-Geer, by Baron de Selys Longchamps.—On the chemical composition of krokydolite, and on the fibrous quartz of South Africa, by A. Renard.—On the Chinese philosopher, Lao-tse, a predecessor of Schelling in the seventh century, B.C., by M. C. de Harlez.—An ambassador of the Duke of Alençon at the court of Queen Elizabeth, by Baron Kervyn de Lettenhove.—On a portrait of Van Dyck's grandmother in the Este Gallery, Modena, by Henry Hymans.

Atti della R. Accademia dei Lincei, July 1884.—On the coexistence of different empirical formulas, and in particular on those containing the capillary constant of fluids or the cohesion of solids, by Adolfo Bartoli.—Report of the committee appointed to rearrange the Corsini Library recently acquired by the Academy. This valuable library was found to comprise altogether 39,082 works, including 5903 Elzevirians, Aldines, and other old and rare editions, 2511 MSS. and 191 volumes of music, besides 116 portfolios of engravings and 17,733 prints and drawings.—Meteorological observations made at the Royal Observatory of the Capitol during the month of June 1884.

Rivista Scientifico Industriale, October 31, 1884.—Variations in the electric resistance of solid and pure metallic wires under variations of temperature, by Prof. Angelo Emo.—Boulier's pyrometer, described and figured by M. Lauth.—The gigantic fossil turtle of Verona, described by S. Capellini.

November 15–30, 1884.—Variations in the electric resistance of solid and pure metallic wires under variations of temperature (continued); part 2, original determinations of the electric resistance of the chief metallic wires under different temperatures, by Prof. Angelo Emo.—On the oxidation of sulphur by ozone, by S. Zinno.—The Ammonites of the province of Venice, described and figured by T. A. Catullo.

SOCIETIES AND ACADEMIES

London

Geologists' Association, January 2.—On some recent views concerning the geology of the North-West Highlands, by Henry Hicks, M.D., F.G.S., President of the Association. The author stated that as the *Proceedings* of the Association contained several papers dealing with the controversy concerning the rocks of the North-West Highlands of Scotland, he thought it advisable to call the attention of the members to views contained in an important article published in NATURE (p. 29) by the Director-General of the Geological Survey, and in a "Report on the Geology of the North-West of Sutherland," by Messrs. Peach and Horne, in the same number, which cannot fail either to change entirely the future character of the controversy, or bring it rapidly to a satisfactory issue. Because of the positions held by the chief disputants on the one side, the controversy had assumed, to a great extent, the appearance of being one between official surveyors and some amateurs, who had been led to study the questions involved in it. The well-known and widely-accepted views first put forward by Sir R. Murchison, that there were clear evidences in the North-West of Scotland of a "regular conformable passage from fossiliferous Silurian quartzites, shales, and limestones upwards into crystalline schists, which were supposed to be metamorphosed Silurian sediments," were fully adopted by the official surveyors, including Sir A. C. Ramsay and Prof. Geikie, also by the late Prof. Harkness and others, who had examined the areas. Prof. Nicol, of Aberdeen, however, for many years stoutly contested Sir R. Murchison's views, and maintained that they were based on erroneous observations. Unfortunately, at that time his views did not meet with much approval. In the year 1878 the author re-opened the contro-

versy by calling attention to some sections examined by him in Ross-shire, which he maintained did not bear out the views of Sir R. Murchison. He also suggested a modified interpretation of the views of Prof. Nicol. Since then many areas in Ross and Sutherland have been examined by Mr. Hudleston, Prof. Bonney, Dr. Callaway, Prof. Lapworth, and Prof. Blake, and their conclusions showed that though differences of opinion prevailed on some points, yet all were agreed as to there being no evidence in the areas examined by them to support the Murchisonian view of a conformable upward succession. Many other facts of great importance were brought out in these inquiries. The author expressed gratification at the candid manner in which the whole question had been dealt with by the Director-General and the Surveyors in their recent report, and at their readiness in acknowledging, after due examination in the course of surveying and mapping parts of the areas referred to, that they had found the "evidence altogether overwhelming against the upward succession which Murchison believed to exist."

EDINBURGH

Mathematical Society, January 9.—Mr. A. J. G. Barclay, President, in the chair.—Prof. Chrystal read a paper on the problem to construct the minimum circle enclosing n given points on a plane; Dr. Thomas Muir discussed the equation connecting the mutual distances of four points on a plane; and Mr. J. S. Mackay gave two notes on a theorem and a problem in geometry which had previously been brought before the Society.

PARIS

Academy of Sciences, January 5.—M. Bouley, President, in the chair.—Obituary notice of M. Victor Dessaignes, who died at Vendôme on January 5, by M. Berthelot.—Chemical studies on the skeleton of plants, part iii., by MM. E. Fremy and Urbain.—Note on the earthquakes in the south of Spain, by M. Hébert. These disturbances, the most serious that have been recorded throughout the historic period in Spain, are attributed exclusively to local causes, and especially to the structure of the soil, which is here formed of secondary strata, folded, overlapped, broken by numerous faults, and often traversed by old and recent eruptive rocks.—On a hydrate of chloroform, by MM. G. Chancel and F. Permentier.—Studies in the reproduction of phylloxera; distribution of the sulphuret of carbon amongst the vines by means of machinery, by M. P. Boiteau.—Equatorial observations of Barnard's and Wolf's comets made at the Observatory of Algiers (0.50 inch telescope), by MM. Trépied and Rambaud.—Observations of Encke's comet made at the same observatory, by M. Trépied.—On the internal constitution of the globe, by M. O. Callandreau.—On a generalisation of the theory of Abel, by M. H. Poincaré.—On a method of treating universal periodical transformations, by M. S. Kantor.—Note on the theory of electro-dynamic induction, of which the integral law is given by Neumann's theorem, by M. P. Duhain.—A new theorem on the dynamics of fluids, by M. E. F. Fournier.—On the laws of chemical dissolution, by M. H. Le Chatelier.—Determination of the atomic weights of carbon, phosphorus, tin, and zinc, by M. J. D. Van der Plaats.—On the saturation of phosphoric acid by the bases, by M. A. J. Joly.—On the preparation of pure and highly concentrated oxigenated water, by M. Hanriot.—On fusibility in the oxalic series, by M. L. Henry.—Heat of combustion of acetal, crotonic aldehyde, isobutyric acid, and of some other substances of the fatty series, by M. W. Louguinine.—On the germination of plants in soils abounding in organic substances, but free from microbes, by M. E. Duclaux.—Observations on the previous paper, by M. Pasteur.—Fresh researches on the doundaké plant (*Cephalina esculenta*, Schum.), and on its active principle doundakine, by MM. E. Heckel and F. Schlagdenhauffen. The doundaké is described as an astringent and a febrifuge capable of replacing quinine, as well as a dye yielding a beautiful yellow colour worthy of the attention of dyers. It flourishes in Senegambia, Sierra Leone, and other parts of West Africa, and in many respects closely resembles the Morinda of the South Sea Islands.—On the presence of the genus Equisetum in the lower coal-measures of Beaulieu, Maine-et-Loire, by M. Ed. Bureau.—Influence of altitude on vegetation and the migration of birds of passage, by M. Alf. Angot.

BERLIN

Physiological Society, December 12, 1884.—Prof. Eulenburg spoke on investigations into the sense of temperature, which he had instituted specially for diagnostic purposes. As a test of the cutaneous perceptions in this respect, the only method available in practice was that of ascertaining the least differences perceived, and for this purpose the speaker had constructed special instruments which could be used to examine the sense of pressure as well as of temperature on the part of the skin. These instruments he laid before the Society. The apparatus for testing the sense of temperature consisted of two mercurial thermometers fastened on a transverse piece, with flat discoid tubes, one of which was fixed, the other movable. The fixed tube was surrounded at its lower part with metallic wires, by means of which, and an electric current, it could be warmed at pleasure. Both were placed beside or after one another on the spot to be examined, and the least difference of temperature which could be perceived was ascertained. When the temperature of the skin was below 27° C., its sensitiveness both to heat and cold was too obtuse for available results to be attained. In order to determine a normal scale above this lin it, Prof. Eulenburg carried out a large number of measurements, which resulted in showing a great diversity in sense of temperature at different parts of the body. The sensitiveness to warmth was highest at the forehead and at the dorsal side of the last phalanges. At both these places differences of 0·2° C. were distinctly perceived. The least sensitiveness to warmth, on the other hand, was shown at the higher end of the anterior side of the upper part of the thigh, at the epigastrium, and in the median line of the back. At these places, only differences as large as from 0·9° C. to 1·1° C. were perceived. Sensitiveness to cold was likewise greatest at the forehead, and least at the epigastrium and back, but the degree of sensitiveness to cold did not always coincide with that of thermal sensitiveness at particular parts of the body, certain spots showing more sensitiveness to differences of heat, others to differences of cold. From the circumstance that the sense of temperature was more developed in the hands and face, which were exposed, than in those parts usually covered, and so far protected from variations, the speaker thought he was justified in inferring that the more delicate sense of temperature was an acquired sense. It was a striking fact that the tip of the tongue, so keen to mark variations of taste, was very dull in distinguishing variations of temperature. While engaged in these investigations Prof. Eulenburg became acquainted with the labours of Dr. Goldscheider, who, in the same manner as Herr Blix had done somewhat earlier, but, independently of this gentleman, came to the conclusion, as the result of a series of experiments, that the perceptions of temperature on the part of the skin had their seat in a large number of distinct cold and warmth points distributed over the whole body in definite complicated arrangement, the former of which (the cold points), under chemical as well as under electrical and mechanical stimulus, generated only the feeling of cold, the latter, under the same stimuli, only the feeling of warmth; that at all parts of the body there were a number of cold points which were easy to identify, and which were called cold points of the first class; and that, in addition, there were a larger number of cold points, more difficult to identify—cold points of the second class. Prof. Eulenburg repeated Dr. Goldscheider's experiments, and found them generally confirmed. He had further studied the distribution of the warm and cold points, both in himself and other persons, in such a manner that he marked with a fine pencil on the skin each warm or cold point found during examination, and then had an impression of the points so found made on wax paper, which he had laid over them. As a result of this operation it appeared that the forehead and the dorsal side of the phalanges had the most, the epigastrium the fewest, cold points. If the same spot of skin were examined on different days, the cold points of the first class always remained the same, while those of the second class varied, being found in larger number on one day than another. This diversity on different days appeared to coincide with the changes of temperature in the skin. The same relations held good in regard to the warmth points, which were separated locally from the cold points by tracts thermally insensible. The distribution of cold and warm points was not the same on all parts of the body. In some places the number of cold points predominated, in others the number of warm points. In the back of the hand, near to the wrist, for example, the number of warm points was in a majority, while towards the fingers the number of cold points preponderated. On comparing symmetrical parts of the body, it appeared that neither in number nor in the way in which they were distri-

buted did the cold points on one side resemble those on the other. Prof. Eulenburg further confirmed Dr. Goldscheider's conclusions that in particular parts of the skin, between the cold and warm points, lay the points of pressure which were sensitive to touch but not to differences of temperature. The existence, on the other hand, of special points for perceiving pain due to temperature the speaker had been unable to verify. Under the stimuli inadequate to temperature feeling, as the electrical and mechanical, he had tried the electric current with positive results. A moderate stream, producing in the skin the well-known prickly feeling, having by means of a pointed electrode been introduced into a cold point, generated a decided feeling of cold. Mechanical stimuli, which should produce the same effect, failed, however, in Prof. Eulenburg's experiments to do so.

Physical Society, December 19, 1884.—Prof. Lampe gave some interesting historical notes on the calculations respecting solids of attraction, the results of which he had communicated at the sitting of November 21. In these problems he had started with a solid of greatest attraction, in regard to which Gauss had laid down the law that its attraction was related to that exercised by the same mass in globular form on a point of its surface, as $3 : \sqrt[3]{25}$. This law was found briefly adduced in a note in Gauss's treatise on capillarity, without any proof either there or anywhere else. Although Prof. Schellbach, who in 1845 calculated the form of the body of greatest attraction, ascribed the adduced law to Gauss, yet Prof. Lampe, in consideration that Gauss did not prove the law referred to and introduced it with the word "constat," was of opinion that it must have been already proved before the time when it was cited by Gauss. He had now, then, in point of fact, succeeded in tracing the author of the law. It originated, namely, with John Playfair, who, in 1809, in a treatise "On the Solid of Greatest Attraction," had calculated the form of such a body, and with reference to the magnitude of its attraction had arrived at the result already stated. In the same treatise John Playfair had dealt with a part of the problems brought before the Society by Prof. Lampe, and in respect of the cone and cylinder had come to the same results as himself. In calculating, however, the attraction of an ellipsoid flattened at the poles, he had, as was shown more at large by the speaker, committed an error, in consequence of which he had arrived at the conclusion that in the case of any eccentricity of the meridians the attraction was less than in the case of eccentricity 0, that is, than in the case of a globe. The fact, on the other hand, was that with oblateness the attraction at first increased and approached to that of the solid of greatest attraction, though yet without ever quite reaching it. It then diminished, till finally it sank to 0, when the pole coincided with the middle point. Let the attraction of a homogeneous mass in globular form be equal to 1, then the greatest attraction which this mass was in any case able to exercise was equal to 1·025986, while the maximum of attraction in an oblate rotatory ellipsoid was equal to 1·02213. Whether John Playfair's error had been already elsewhere observed or corrected was not known to the speaker. Altogether John Playfair's treatise appeared to have lapsed into oblivion, seeing that in the manuals of mechanics the law of maximum attraction being to the attraction of a ball as $3 : \sqrt[3]{25}$ was universally imputed to Gauss, and the calculations of the solid of greatest attraction, which John Playfair had already worked out, to Schellbach.—Following up this address Dr. Kœnig communicated the plan of an investigation which he contemplated carrying out in conjunction with Dr. Richarz. The investigation had for its object to determine with greater precision than had hitherto been done the mean density of the earth. The most exact measurements hitherto taken on this question came, as was known, from Herr von Jolly, in Munich, who, in a high tower, experimented on a balance, on one scale of which hung a wire, 21 m. long, bearing another scale at the bottom. After balancing a body in the upper scale and then transferring it to the scale 21 m. lower, the body was found to be somewhat heavier in the latter case in consequence of the more powerful attraction there exercised on it by the earth. On next placing under the lower scale a lead ball weighing 110 centner, and repeating the experiment, he found a greater increase on the upper scale weight than in the first instance. From the relation of these augmentations of weight and the volume and specific weight of the lead ball, Herr von Jolly calculated the mean density of the earth. Such a mode of measurement, however, laboured under this unavoidable source of error, that there was no means of safe-guarding the long wire from differences of temperature. Dr. Kœnig and Dr. Richarz had now, independently of each other, devised another method of utilising the balance for the purpose of determining the mean density of the earth. Instead of placing the lead ball 21 m. under the upper scale, they brought the heavy body directly under the upper scale, whence a line, passing through a perforation of the heavy mass, bore the lower scale immediately underneath it. When, now, a body was weighed in the upper scale, the mass of lead acted in a sense similar to that of the force of gravity, and its attraction was added to gravitation. When, on the other other hand, a body was weighed in the lower scale, the mass of lead operated in an opposite direction, and its attraction was subtracted from gravitation. By this experiment, therefore, a double effect was obtained from the mass of lead instead of the single effect in Herr von Jolly's experiment. Again, by bringing a second equally large mass of lead under the scale of the other side, disposing it in the same manner as the first mass, the effect of the mass of lead might be multiplied fourfold. An equilibration might be made by placing the weight on one side in the upper, on the other side in the lower, scale. Then the weights might be transposed. Independently of the advantage of a fourfold comparative estimate of the attraction of the mass of lead, all disturbances due to differences of temperature were by this method entirely obviated. The precision of the measurement would be still further enhanced by using a mass of lead of 2000 centner. The total mass of lead would compose a block, the most suitable form for which had yet to be theoretically determined. In the centre, above this block, would stand the balance, and the wires of both scales would pass through two equal perforations, at the ends of which, under the block, would depend the two lower scales. The construction of such a block of lead would be rendered possible by making it consist of 1300 separate pieces capable of being joined together into the form desired, and after a series of experiments they might be fitted up anew, so as to secure compensation for any errors due to unequal interior structure of the blocks. Of these masses of lead a parellelopiped would have a side of 2·5 m. and a height of 1·5 m. As was self-evident, the precision of the balance was a matter of extreme moment for these measurements. The mechanist who had undertaken their construction had engaged to produce a sensitiveness of one hundred millionth for the weight of 1 kg. used in such measurements. He had further engaged, by an adequate modification of the construction, to obviate the error arising from the circumstance that the edges never corresponded mathematically with that term, but had always more or less diameter, so that with the inclination of the beams the plane of support changed. Dr. Kœnig hoped to be able in the course of a year to announce the numerical results of the experiment.

CONTENTS

THURSDAY, JANUARY 22, 1885

HIGH-LEVEL METEOROLOGY

Bericht über die Errichtung der Meteorologischen Station auf dem Säntis und ihre Thätigkeit, September 1883 *to August* 1884. Erstattet von R. Billwiller. (Zurich, 1884.)

Journal of the Scottish Meteorological Society. Third Series, No. 1.

WE briefly noticed at the time (NATURE, vol. xxix. p. 413) M. Billwiller's first report on the Swiss high-level station on Säntis, in the Canton of Appenzell; and his second report has now come to hand, giving, along with a rapid history of the establishment of this first-class meteorological observatory and its equipment, an excellent *résumé* of two full years' observations, ending August 31, 1884. A comparison of the results with those obtained for Ben Nevis presents several points of considerable importance.

On Säntis, 8094 feet high, the mean annual atmospheric pressure is 22·237 inches, the highest monthly mean being 22·429 inches in August, and the lowest 21·993 inches in March. On Ben Nevis, 4406 feet high, the mean annual pressure is 25·257 inches, the highest mean being 25·400 inches in July, and the lowest 25·141 inches in January. The differences between the highest and lowest is thus 0·436 and 0·259 inch respectively. On Säntis the mean annual temperature is 28°·2, the highest monthly mean being 41°·4 in August, and the lowest 18°·0 in January. The annual mean for Ben Nevis is 30°·9, the highest monthly mean being 41°·3 in July, and the lowest 22°·0 in February. The lower mean temperature of Säntis is thus wholly due to its colder winters.

But the most marked difference in the climates of the two situations is revealed by the hygrometer. On Säntis the mean annual relative humidity for the two years is 84, the highest monthly mean being 93 in September 1882, and the lowest 71 in March 1884. On Ben Nevis, on the contrary, the lowest mean monthly humidity was 90 for May 1884, and the highest for January of the same year, when the mean dry bulb was 25°·50, and wet bulb 25°·47, showing an approximate humidity of 99. Indeed, so thick and continuous was the covering of mist, fog, and cloud in which Ben Nevis was wrapped during this month, that the difference between the mean coldest and warmest hour of the day in winter is only half a degree. We have drawn attention (vol. xxx. p. 336) to the sudden changes of humidity which characterise the climate of Ben Nevis in connection with anticyclonic movements, when the atmosphere passes rapidly from a state of the most complete saturation to a state of dryness greater than is ever reached at lower levels in this part of Europe, and that on such occasions the temperature rapidly rises, till sometimes it even rises higher than at Fort William, about 4400 feet lower down. Now M. Billwiller gives an extremely valuable column in one of the tables, showing the minimum relative humidity observed each month, from which we see that a humidity of 21 occurred in August 1883, and that on six of the other twenty-three months a humidity less than 30 was recorded. The importance of these observations from Ben Nevis and Säntis on the great movements of the atmosphere in cyclones and anticyclones, and on the Föhn and the various theories that have been suggested in explanation of its phenomena, need not here be insisted on.

On Säntis the annual rainfall, inclusive of melted snow, was 67·83 inches. The heaviest rainfall of any month was 15·12 inches in July 1883, and the lightest 0·71 inch in February of the same year. On the top of Ben Nevis, for the five months from June to October of 1882 and 1883, the mean rainfall was 44·35 inches; and on Säntis, for the same five months of 1883 and 1884, the rainfall was 43·95 inches—the summer rainfall of the two places being thus nearly the same. These amounts are very greatly in excess of what several theories of the distribution of the rainfall on the slopes and tops of mountains would lead us to expect. In discussions of this question it will be necessary to give more pointed attention than has yet been given to the great vertical movements in the atmosphere which are disclosed by the hygrometric observations of these high-level stations.

Of even greater interest are the hourly observations at the two observatories, especially those relating to atmospheric pressure and wind. At the two places the hourly curves of pressure for different seasons run closely parallel to each other. In June, when the more special features of the curves are most pronounced, they closely approximate to a single diurnal minimum and maximum. The minimum occurs from 5 to 6 a.m., and the maximum from 9 to 10 p.m., the daily range being 0·039 inch on Säntis, and 0·030 inch on Ben Nevis. Each curve shows an extremely shallow secondary minimum from 5 to 6 p.m. which, as compared with the secondary maximum immediately preceding indicates a fall not exceeding 0·003 inch.

This secondary maximum occurs at 3 p.m. on Säntis, and at 3.30 p.m. on Ben Nevis, and is the analogue of the morning maximum which occurs at lower levels in the same localities six hours earlier. On Mount Washington, United States, this maximum occurred in June 1873 at 8.30 a.m. at the base of the mountain, 2898 feet above sea-level, 10 a.m. at 4059 feet, 11 a.m. at 5533 feet, and at noon on the top of the mountain at a height of 6285 feet. On Ben Nevis, while pressure is steadily falling at the base of the mountain from 9 a.m. to 4 p.m., on the peak it continues steadily to rise; and the same phenomena doubtless obtain at Säntis.

At the same time the diurnal velocity of the wind on these peaks shows even a stronger contrast when compared with the diurnal velocity at lower levels. At low levels and on plateaux of considerable extent the velocity of the wind falls to the daily minimum early in the morning, and rises to the maximum at or immediately after noon, or about the time of strongest insolation. The following table, showing the diurnal variation in the wind's velocity on Ben Nevis, Säntis, and Mount Washington in summer, and on Ben Nevis in winter, presents for these elevated peaks curves precisely the reverse of the curves for velocity at lower levels. The figures express in percentages the excess or defect of each hour's velocity from the daily mean :—

	Ben Nevis, June—Aug. 1884	Säntis, June—Aug. 1884	Mt. Washington, May—June. 1873	Ben Nevis, Dec.—Feb. 1883—84
1 a.m.	15	18	20	9
2 ,,	15	24	15	7
3 ,,	19	24	9	8
4 ,,	12	16	8	7
5 ,,	7	12	8	3
6 ,,	8	8	1	5
7 ,,	0	4	− 2	3
8 ,,	2	− 7	0	1
9 ,,	− 3	− 13	− 8	− 3
10 ,,	5	− 15	− 10	− 6
11 ,,	− 11	− 20	− 12	− 8
noon	− 15	− 18	− 19	− 7
1 p.m.	− 11	− 19	− 16	− 7
2 ,,	− 15	− 17	− 12	− 7
3 ,,	14	− 11	− 15	− 7
4 ,,	10	− 11	− 13	− 7
5 ,,	− 10	− 9	− 7	− 3
6 ,,	− 5	− 8	− 4	− 4
7 ,,	− 3	7	− 1	5
8 ,,	− 0	10	− 3	3
9 ,,	0	5	5	4
10 ,,	9	2	15	8
11 ,,	11	7	19	8
midnight	9	9	19	6

Hence the maximum occurs on these heights shortly after midnight, and the minimum shortly after noon. Now it will be seen that these diurnal maxima and minima occur nearer midnight and noon than do the phases of the other meteorological phenomena, thus suggesting a direct connection with solar and terrestrial radiation. It is singular that, while the diurnal period of strongest insolation determines the occurrence of the maximum velocity of the wind over extensive land surfaces, it determines the minimum velocity on peaks rising to a great height above the land surfaces surrounding them. Of special importance in its bearings on the question is the curve of diurnal variation on Ben Nevis for the three winter months of 1883-84, when the mean velocity of the wind was nearly double that of the summer months. In that season Ben Nevis was under a deep covering of snow, the sky clouded nearly the whole time, the air frequently darkened with dense drifting fogs, and the difference between the mean lowest and highest hourly temperature only half a degree. Notwithstanding the practical uniformity of temperature of the surface of the top of Ben Nevis during the twenty-four hours of the day, the curve of the diurnal variation in the wind's velocity was as clearly marked in winter as in summer, and the two curves were alike in showing the occurrence of the maximum shortly after midnight, and the minimum shortly after noon. We must therefore conclude that the peculiar type of the diurnal curves of wind velocity on these elevated peaks is altogether independent of the temperature of the surfaces over which the winds blow. The results point not obscurely to an investigation of the relations of the visible and invisible vapour of the atmosphere to solar and terrestrial radiation as an inquiry of first importance in meteorology.

OUR BOOK SHELF

Exercises in Electrical and Magnetic Measurement. By R. E. Day, M.A. New Edition. (London: Longmans, Green, and Co., 1884.)

Mr. Day has produced a new and considerably improved edition of a most useful and valuable little book. Every teacher of electricity whose work is not confined to the beggarly elements of mere phenomena will thank Mr. Day for the admirable selection of problems put together in this volume. Nothing could be a greater boon to the real student than the means thus afforded of testing his knowledge of the exact quantitative laws of the science. If it were not for the historic interest of that rather antiquated instrument—the torsion balance—we should doubt the utility of giving so much attention to it. Although the more modern electrometers have entirely superseded the torsion balance as an instrument of research and of measurement, it has, nevertheless, become so prominently fixed—like some grand old fossil long ago extinct—amongst the characteristic forms of electrical instruments, that examiners still expect candidates for examination to know something about it. On the other hand, the space allotted to moments of torsion and inertia is all too brief, though admirably filled. We must, however, take exception to the practice apparently followed on p. 62, of expressing a moment of couple in *dynes*: it should surely be *dyne-centimetres*. The section on the chemical (or rather thermo-chemical) theory of electromotive force is excellent. The problems comprised under the heading Electromagnetic Measurement are admirable, though perhaps a little beyond most students.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Earthquakes and Terrestrial Magnetism

Mr. W. H. Preece having written to the Astronomer-Royal to ask whether any disturbance of our magnets or our earth-current apparatus was experienced during the recent earthquake in Spain, it may be interesting to communicate also for the information of your readers the result of an examination of our photographic registers in consequence made, and especially in order that what has been remarked may, if possible, receive confirmation.

As respects magnetic movement, the magnets on Dec. 25 last and following days were generally quiet. But on looking more closely at the registers, attention was at once drawn to a small simultaneous disturbance of the declination and horizontal force magnets, occurring at 9h. 15m. on the evening of December 25. Both magnets were at this time set into slight vibration, the extent of vibration in the case of declination being about 2′ of arc, and in horizontal force equivalent to ·001 of the whole horizontal force nearly. The movements have not the character of magnetic movements, and, if in reality produced by the earthquake, are of course simply an effect of the shock, the magnets being heavy bars suspended by silk threads some feet in length. About ten minutes afterwards there is doubtful indication in the horizontal force register of a second disturbance. There is no corresponding perceptible disturbance in the earth-current registers.

No other similar motion is observable either on December 25 or on the following days.

It may be remarked that in Nature for January 1 last (p. 200) the time of occurrence of the earthquake at Madrid is said to be 8h. 53m. p.m. Taking this to be Madrid time, it corresponds to 9h. 8m. of Greenwich time. William Ellis

Royal Observatory, Greenwich, January 15

Teaching Chemistry

The subject of science-teaching in schools, and more particularly the best way in which practical chemistry should be taught, has of late been discussed in the columns of Nature. With the editor's leave, I should like to say a little regarding the methods of teaching chemical science in general.

Nature for January 8 contained notes, by Profs. Sir H. E

Roscoe and W. J. Russell, on "Experiments suitable for Illustrating Elementary Instruction in Chemistry." These notes appear to me to be very useful as a rough guide to the school-teacher. But unless the teacher is able to arrange the experimental illustrations so that some conclusions regarding the elementary principles of chemistry shall be drawn from the results he obtains, which conclusions shall then be submitted to experimental examination, I think the notes will fail of their object.

It is to the want of progressiveness in the ordinary chemical course that I wish to draw attention.

The student of physics advances; he feels his way from one set of phenomena to another; he generalises, and gets hold of some principles on which he may rest. In the ordinary chemical course the student begins with enthusiasm; he is delighted with the experiments, and he takes a lively interest in the manipulative failures of the lecturer. But, after a little, the student finds that he is not progressing. When he has been told, and shown, the properties of hydrogen, oxygen, and water, he is expected to take as much interest as ever in hearing a list of properties of nitrogen and oxides of nitrogen. Then he fills his note-book with many facts regarding ammonia and nitric acid, and so on.

Now I do firmly believe that chemistry is a branch of science, and that it may be taught as such. I think it is possible, in a course of lectures on chemistry, to lead the fairly intelligent and not very idle student from simple facts about everyday occurrences to the difficult and apparently remote discussions regarding the architecture of molecules, in which chemists so much delight.

If lectures on chemistry were arranged so that principles should be discussed and amply illustrated by well-chosen experiments, instead of being (as I am afraid is still too often the case) repetitions of disconnected facts about a string of elements and compounds, I believe this branch of science would rapidly develop in this country. It seems to me that the distinction implied in the commonly-used terms *chemistry* and *chemical philosophy* is radically unsound. There are not two chemistrys, but one chemistry. We do not speak of physics as different from natural philosophy.

What we want is to convince our students that they are dealing with realities. I am continually presented with answers to questions, which perhaps demand a knowledge of the laws of chemical combination, wherein a few elementary facts are elevated to the rank of an all-embracing theory, and complex structural formulæ are dealt with in a style of appalling familiarity, as if they were the topics which it is necessary to discuss on the very threshold of chemistry. One is told that chlorine is a monad, that is, it is a "one-armed one"; and then the conclusion is triumphantly announced, "*thus we see why it is*" that hydrogen and chlorine combine to form hydrochloric acid, and so on. The other day I implored a candidate in a certain examination to give me a reason for writing the formula of alcohol C_2H_5-OH rather than C_2H_6O; he told me he had seen the former in a book. This is enough for the average student; and yet these people call themselves students of science. I am afraid the teachers are greatly to blame.

The examiners have undoubtedly much power; but I think the examinations in chemistry are improving as a whole.

When a lecturer in chemistry announces two series of lectures, one elementary and one advanced, is it not very often found that the advanced class is condemned to hear copious details regarding the purification and methods of separation of the rare metals, while the elementary class is entertained with an exhibition of the properties and reactions of the simple and compound gases? But is this chemistry?

I think that the teachers of chemistry must consent to abandon the time-honoured practice of placidly proceeding from element to element, and from compound to compound; they must ask themselves whether they know of any reasons why chemistry should be called a branch of natural science, and, having conscientiously answered this question, they must try to make their students really acquainted with these reasons.

Dr. Sydney Young (NATURE, vol. xxxi., p. 126) has referred to the paucity of good elementary text-books of chemistry. I, too, have felt the want of a really good book in attempting to teach the principles of chemistry to beginners. Is there any elementary book which treats chemistry as a genuine living science?

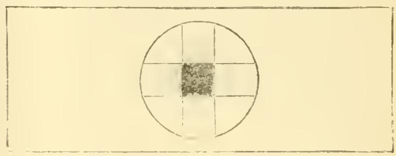
M. M. PATTISON MUIR

Cambridge, January 12

A Method of Isolating Blue Rays for Optical Work

IN many optical experiments, *e.g.* in examining the dispersion of optic axes in crystals, a homogeneous or monochromatic light is required. A fairly homogeneous red light, nearly corresponding to the Fraunhofer line B, can be obtained by a properly-selected piece of red glass placed in front of a good Argand burner or paraffin lamp. For yellow light, nothing can be better than the flame of a Bunsen's burner in which a bead of sodium carbonate is held in a loop of platinum wire. For blue rays, the light transmitted by a solution of cuprammonium sulphate is generally recommended, since the ordinary blue glass coloured with cobalt invariably transmits red rays as well as blue. But the use of a glass cell containing a strong ammoniacal solution is often inconvenient and unpleasant.

I have met with a peculiar kind of greenish-blue glass, used for railway signal lamps, and known as "signal-green glass" (coloured, I believe, with copper in its divalent condition), which is remarkably opaque to the less refrangible rays nearly as far as Fraunhofer's line E, while it transmits a large quantity of blue and some green light. By combining a piece of this glass with a piece of rather deep-tinted cobalt glass, the red rays transmitted by the latter may be wholly stopped, and only the part of the



spectrum between F and G is transmitted, constituting a light at any rate not less homogeneous than that transmitted by solution of cuprammonium sulphate.

This "signal-green glass" is also useful in illustrating selective absorption of light by different media. If, for instance, a piece of it is superposed on a piece of properly-selected red glass, each absorbs what the other transmits, and practically no luminous rays survive the two; only a faint neutral-tinted light struggling through, even when strong sunlight is used.

This can be well shown on the screen by fixing a narrow strip of the "signal-green glass" vertically in a lantern-slide, and crossing it with a similar strip of red glass fixed horizontally in the same frame. The square space where the two overlap appears absolutely black.

The same arrangement is useful for other absorption-experiments, since the original colours of the media are shown, as well as the result of their superposition.

It is necessary to remember that much lighter tints are wanted for lantern-work than for subjective experiments.

Eton College, January 10 H. G. MADAN

Barrenness of the Pampas

IN the admirable address of Prof. Asa Gray at Montreal, he alludes to the singular absence of trees and herbaceous plants throughout the Pampas or vast level plains of the South American continent, and he indorses the opinion of Mr. Darwin and Mr. Ball that this absence is due to the fact that the only country from which they could have been derived could not supply species adapted to the soil and climate. As this is a subject to which I paid considerable attention during a long residence in South America, I venture to call attention to the explanation of this phenomenon, which my observations gave rise to as described in my "Visit to South America," 1878.

The peculiar characteristics of these vast level plains which descend from the Andes to the great river basin in unbroken monotony, are the absence of rivers or water-storage, and the periodical occurrence of droughts, or "siccos," in the summer months. These conditions determine the singular character both of its flora and fauna.

The soil is naturally fertile and favourable for the growth of trees, and they grow luxuriantly wherever they are protected. The Eucalyptus is covering large tracts wherever it is inclosed, and willows, poplars, and the fig, surround every estancia when fenced in.

The open plains are covered with droves of horses and cattle, and overrun by numberless wild rodents, the original tenants of

the Pampas. During the long periods of drought which are so great a scourge to the country, these animals are starved by thousands, destroying, in their efforts to live, every vestige of vegetation. In one of these siccos, at the time of my visit, no less than 50,000 head of oxen and sheep and horses perished from starvation and thirst, after tearing deep out of the soil every trace of vegetation, including the wiry roots of the Pampas grass.

Under such circumstances the existence of an unprotected tree is impossible. The only plants that hold their own, in addition to the indestructible thistles, grasses, and clover, are a little herbaceous oxalis, producing viviparous buds of extraordinary vitality, a few poisonous species, such as the hemlock, and a few tough, thorny, dwarf acacias and wiry rushes, which even a starving rat refuses.

Although the cattle are a modern introduction, the numberless indigenous rodents must always have effectually prevented the introduction of any other species of plants, large tracts are still honeycombed by the ubiquitous biscacho, a gigantic rabbit, and numerous other rodents still exist, including rats and mice, Pampas hares, and the great nutria and carpincho on the river-banks. That the dearth of plants is not due to the unsuitability of the subtropical species of the neighbouring zones, cannot hold good with respect to the fertile valleys of the Andes beyond Mendoza, where a magnificent hardy flora is found. Moreover, the extensive introduction of European plants which has taken place throughout the country has added nothing to the botany of the Pampas beyond a few species that are unassailable by cattle, such as the two species of thistle which are invading large districts, in spite of their constant destruction by the fires which always accompany the siccos. EDWIN CLARK

Marlow, January 15

Japanese Magic Mirrors

IN your last week's issue (p. 249) appears a paragraph from a paper by Dr. H. Muraoka of Tokio on "The Magic Mirror of Japan," and reference is made to the interest these mirrors have excited, and the large number of writers and lecturers who have taken up the subject of their construction. I have read most of what has been written and stated upon the subject, and dissent from all that has come under my notice, especially the ingenious theories of non-continuous convexity of surface. My reason for dissent is that I have seen one, and for some time it was placed in my care by a friend who made it himself in this country.

He, and I have no doubt correctly, assumed that the difference in reflection was due to difference of density, and that by hammering the flat surfaces of the large letters on the back of the mirror, an increased density would be produced which would extend to the front of the mirror, which would then receive a slightly higher polish, sufficient to give the magical figures. From this reasoning he concluded that any metal which could be polished so as to reflect well could be treated in the same way with the same results.

His first experiment was with a half-crown piece, and the success was complete; he had the reverse rubbed down, until a perfectly smooth and polished surface was produced, the reflection from which, on white paper and with a strong light, showed the head of the obverse quite distinctly, but differing from the magic mirrors in this respect, that it was less bright than the other portion of the disk, because the coining-press would bring its greatest pressure upon the field and not upon the type. T. C. A.

Edinburgh

Peculiar Ice-Forms

I INCLOSE a letter with which I have been favoured giving another case of the curious ice-structure lately described in NATURE. The circumstances are very similar to those of the other cases. B. WOODD SMITH

Hampstead, January 16

Regent Road, Leicester, January 13, 1885

DEAR SIR,—Pray excuse my troubling you with an extract from my note-book as to a peculiar form of ice which I saw on the morning of September 21, 1880. I started to descend from the Æggishorn hotel a little before 6, and when I suppose that I was about a thousand feet down, just before coming to the wood, I noticed some curious-looking ice just along the bottom of the sloping sides of the path, which here runs in a shallow gulley two or three feet deep. The ice ran along the side of the path for some yards. I took up several pieces in my hands and examined them, and made a rough sketch, which I reproduce without any additions. The ice was made up of bundles of little rods about one-sixteenth of an inch in diameter and half an inch long. They were roundish and rough or fluted on their sides, and tapered at each end, and in some cases the ends finished with a little thread of ice about a quarter the thickness of the body of the rod. The rods stuck together and were a little curved, and formed roughly two layers, or tiers, one above the other. My note states that these bundles of ice-rods lifted up the dirt and small stones on the top of them. The day before there had been snow with a thaw.

My impression was at the time that water, rising through the ground and being frozen just before it reached the surface, gave rise to these peculiar ice-forms.

You are quite at liberty to make any use you please of this note. I am, dear Sir, yours faithfully,

JOHN D. PAUL

Iridescent Clouds

THE iridescent colours in clouds, observed in England and Scotland in December last, were also visible here December 8, 9, 10, and 12. On the first day, about 3 p.m., the coloured clouds were arranged in a horizontal layer about 20° high, between 20° and 80° azimuth west. In the half altitude a fine stripe broke forth from the background of the ordinary (but not dense) cumulo-stratus.

The opinion of one of your correspondents that a connection exists between this and the sky-glows of the last two years, is contradicted by the circumstance that the phenomenon has been observed here several times before, viz. 1871, February 22, March 1, May 10; 1874, January 13; 1875, February 17; 1881, December 27; 1882, January 11, February 22, July 13. I make the following extract from the observation of 1882, January 11, showing the peculiar changes in the colours:—at 3.30 p.m. (sun set at 3.20) extremely beautiful iridescent cirro-stratus in south-west, in an altitude of 8°—12°. The upper borders, later also the lower, were red, with yellow brims, the rest of the borders and the inner parts very variegated and variable; the light red, commonly seen in mother-of-pearl, changed through crimson into blue-green, and then into grass-green. On some spots this change was repeated twice. The variation of the colours continued till after 4 o'clock; at 4.30 the colour was the ordinary red. The form of the clouds varied very slowly.

1881, December 27, an isolated brilliantly-coloured cloud was observed through two hours at least. A drawing of it by Dr. Reusch (in woodcut) is inserted in the Norwegian *Naturen* 1882, No. 1.

The most striking cases of this phenomenon have been observed here when mild and dry weather set in after frost.

H. GEELMUYDEN

University Observatory, Christiania, January 11

Solar Phenomenon

AS I see no record of what I witnessed on the afternoon of the 14th instant in NATURE of the 15th, I trouble you with this brief statement. At 3h. 20m. p.m. on that day I was struck by the appearance of the sun, which was crossed by a light stratus cloud of a clearly-defined outline, below which appeared what seemed a column of light of uniform width, down to the horizon, the width being somewhat less than the sun's diameter. By 3h. 30m. the definition of this parallel beam was less marked, but the sun presented to me the appearance of an oblong, suggesting three partially-superposed disks. Soon afterwards the sun was wholly obscured. The day had been cold, the temperature being never far from freezing-point in the shade. I have on former occasions, and in summer, seen the parallel beam striking upwards, once in association with a mock sun.

Valentines, Ilford C. M. INGLEBY

A Cannibal Snake

WITH reference to notes as to Ophiophagous snakes, which appeared at pp. 216, 269, 312, and 408 of the last volume of NATURE, I inclose a communication received by me this morn-

ing from Borneo. The habit seems general, and, according to the above letters, not confined to venomous or non-venomous varieties. EDWARD F. TAYLOR

St. Augustine's College, Canterbury, January 13

"*Sarawak, Borneo, November* 11, 1884

"The inclosed cutting from NATURE was sent me by H. Brooke Low, Esq., resident of Rejang, with a desire that I should forward my experience (which was similar to Mr. Evans's) to your paper. A young Dyak youth was walking up the hill towards my house, when a snake sprang out of the bank and fastened itself on the boy's jacket, just under the right arm. Fortunately, its fangs got caught in the cloth, and the boy escaped unhurt. Eventually, the reptile was killed and brought to the house. It measured five feet and some odd inches in length. In examining its fangs I noticed in its mouth the tail of another snake, and, on pulling it out and comparing them, I found it to be a few inches *longer* than the outside snake, though not quite so thick. I have come to the conclusion that this snake is the *Ophiophagus elaps* of the Straits. The native name for it is 'Ular Kendawang.' It is more deadly, more agile, and more beautifully marked than the 'Ular biliong' mentioned by Mr. Evans. So fascinatingly beautiful is the appearance of this snake, that in Dyak poetry one of their heroes is described as 'Crowned with the cast skin of the Ular Kendawang,' thus attributing to the hero that comeliness, agility, and fearlessness for which the 'Kendawang' is noted. I have reason to believe that the 'Ular biliong,' or axe snake (from the shape of its head), mentioned by Mr. Evans is an Ophiophagus, but it is not what is called the 'Elaps.' Its movements are sluggish, and its poison is not nearly so deadly as that of the 'Kendawang.' The distinctive marks of the 'Kendawang' are a reddish head and tail, the red of the tail being about twice the length of the head. The ground colour of the body is generally of a dark gray, but I have seen them of a silver gray, and also dark brown. A light streak of flesh-colour runs down the back, and the edges of it are serrated with vermilion and metallic-green spots, with just enough of white and yellow to make a most pleasing combination of colour. Besides these two, there are two other species belonging to the Ophiophagous class. The native names are 'Kengkang mas,' or 'Tinchin mas,' *i.e.* golden-ringed; and 'Matikor,' *i.e.* dead-tailed, and these four species are, I believe, very common throughout the Malay Archipelago. "M. J. BYWATER,

"S.P.G. Missionary in Sarawak"

The Canadian Geological Survey

A PHRASE used in your condensed report of my remarks after Sir J. H. Lefroy's paper, read on January 13 at the Colonial Institute, may, I fear, be misunderstood by some of my friends in Canada. I am reported speaking of the Geological Survey of that country as "being slowly conducted." My remarks were not intended to imply the slightest reproach. I explained that progress could not be rapid because of the vast extent of the territory and the natural difficulties of many parts of it. I think, indeed, that it is surprising that, having regard to the means at their disposal, the Survey have accomplished so much. I urged that, as it was impossible for the present staff to prospect specially for minerals without abandoning the general work of surveying, which is of the more importance for science, some specialist should be added to it, to whom the former duty should be assigned. I did not use quite so strong a phrase as that I "*believed* the district north of the St. Lawrence was rich in valuable minerals." My opinion is that, as certain parts are known to be rich, and as there is great uniformity in the geology of the district, it is very probable similar deposits exist in the (very large) unexplored portion. T. G. BONNEY

23, Denning Road, Hampstead, N.W., January 19

ASTRONOMICAL PHENOMENA FOR THE WEEK

1885, JANUARY 25–31

(AS an experiment we have here adopted for the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24.)

At Greenwich on January 25

Sun rises 7h. 50m.; souths 12h. 12m. 40.9s.; sets 16h. 35m.; Decl. on meridian 18° 50′ S.; sidereal time at sunset 0h. 55m.

Moon (1 day past First Quarter) rises 11h. 55m.; souths 19h. 29m.; sets 3h. 12m.*; decl. on meridian 15° 59′ N.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury ...	6 23 ...	10 27 ...	14 31 ...	21 47 S.
Venus ...	6 31 ...	10 29 ..	14 27 ...	22 44 S.
Mars ...	8 6 ...	12 29 ...	16 52 ...	18 54 S.
Jupiter ...	19 6* ...	2 7 ...	9 8 ...	11 10 N.
Saturn ...	12 43 ...	20 46 ...	4 49* ...	21 32 N.

January 26, 16h.—Mercury at greatest elongation from the Sun, 25° W.

Occultations of Stars by the Moon

Jan.	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to left
			h. m.	h. m.	° °
26 ...	B.A.C. 1526 ...	6 ...	19 13 ..	19 49 ...	19 328
27 ...	B.A.C. 1930 ...	6½ ...	20 38 ..	21 30 ...	33 316
29 ...	λ Geminorum ...	3½ ...	2 23 ...	3 21 ...	132 284
30 ...	B.A.C. 3122 ..	6½ ...	20 54 ..	21 59 ...	30 237
31 ...	π Leonis ...	... 5 ...	17 53 ..	18 35 ...	5 255

Phenomena of Jupiter's Satellites

Jan.	h. m.		Jan.	h. m.	
25 ...	4 1	I. tr. ing.	27 ...	0 47	I. tr. egr.
	6 21	I. tr. egr.		19 8	I. ecl. disap.
	21 40	IV. tr. egr.		21 33	II. ecl. disap.
26 ...	0 40	I. ecl. disap.		21 58	I. occ. reap.
	3 31	I. occ. reap.	28 ..	1 33	II. occ. reap.
	3 52	II. tr. ing.		19 13	I. tr. egr.
	6 47	II. tr. egr.	29 ...	19 54	II. tr. egr.
	7 27	III. ecl. disap.		23 19	III. tr. ing.
	22 28	I. tr. ing.	30 ...	2 54	III. tr. egr.

* Indicates that the rising is that of the preceding, and the setting that of the following nominal day.

DUST[1]

MY business this evening is to talk about dust: meaning by dust all suspended foreign matter of whatever kind, and including smoke and fog under the one heading. Coming from England I should naturally begin by saying, well, we all know what dust and smoke are; and even in Canada, I suppose, I may venture to say the same, though I am bound to say that your country, at present, shows a remarkable deficiency in this respect. In an English town dust and smoke are the most noticeable features, and are always ready to perform any insanitary or other function that may be expected of them. In this clear atmosphere none of these functions can be properly performed; disease-germs must languish and die, and their sworn foes, the white corpuscles of the human blood, must thrive amain. Let me say, however, that the air here is not so absolutely free from smoke as I had hoped to find it. Compared with an English town it is a splendid contrast; compared with one's ideal it falls short. Your houses may indeed burn anthracite and wood, but your passenger locomotives do not: I can attest from very recent personal experience, in a journey across this continent, that some of your locomotives emit almost as much smoke as a Clyde steamer, and that the journey would have been much pleasanter if they had emitted less. I also see some factory chimneys rising here and there. If you be not warned in time, you will not realise the blessing of fresh and pure air until you have lost it. It is good to have large manufactures, it is better to retain healthy and pure air. But with proper care the two may go together. Once lose ground in this respect, as we have done in

[1] Evening discourse to the British Association at Montreal, on Friday August 29, 1884, by Oliver J. Lodge, Professor of Physics in University College, Liverpool.

England, and terribly uphill will be the retracement of your steps. The old country has in many things made experiments for you—experiments of which you may reap the benefit, without repeating them, if you choose. The experiment of Protection, which we have tried and abandoned, I dare not here mention except just by name; but I dare mention the experiment we have tried only too successfully, and by no means yet abandoned though we groan under it—that of fouling the atmosphere, wherever a large number of human beings have to live in it, to such an extent that it is not fit to breathe. We have made a terrible mistake, and one that will take perhaps a century to undo. Tax all the necessaries of life and it is a small evil, for the tax may at any time by an Act of Parliament be removed, but pollute the air in which a people have to live and no one can see the end of the evil. You will soon have towns here rivalling Liverpool and Glasgow and Manchester in size, and some day London. Be warned in time.

However, in speaking of dust, I am not going to confine myself to such artificial dust as is made in towns, I shall include everything which Tyndall means when he calls it "the floating matter of the air," all diffused and floating foreign matter, fine or coarse. But the term "floating" is not free from possible misconception, and a better term than floating is sinking. If the two sound antagonistic, then floating was wrong. Foreign particles, whether solid or liquid, are not floating, and cannot float, in air; they are all necessarily sinking through it, and sinking at a well-defined and fairly calculable rate. Consider, for instance, the water globules of a fog, or mist, or cloud. The drops of water appear to float in air, but they are not floating, they are slowly settling down. They may in truth be buoyed up by convection currents, but they never move up *through* the air, they move up *with* the air to some extent, but are always slowly falling through it whether the air be moving or stationary. Are they then like a slowly-falling balloon or soap-bubble? No, they are not buoyed up at all—they are falling as fast as ever they can. Water is 800 times as heavy as air, and a drop of water falls under the influence of this enormous difference in weight. Why does it not fall faster? Just for the same reason as prevents an Atlantic liner from being propelled at 50 knots an hour—skin friction. A ship requires a great force to propel it at 15 knots an hour; break it up into small pieces and it will take vastly more; pound it into infinitely fine dust and it will require an infinite force to propel it at any slow pace. I do not say that a small body as it moves through a fluid experiences more resistance than a large one—it experiences less; but the decrease of resistance is not so rapid as the decrease of its bulk or weight, and consequently a small falling body is resisted more *in proportion to its weight* than a large one. Consider a bullet or a raindrop falling from a great height. As it falls it keeps moving quicker and quicker, but not without limit. Its weight remains constant, the resistance it meets with increases with its speed; hence there comes a time when the two balance and the body is in equilibrium. It then ceases to gain speed: it has attained its "terminal velocity." Even if thrown down faster than this it would slacken till it attained it. Now this terminal velocity is greater for a bullet than for a small shot, is greater for a large raindrop than for a small one, and for a mist globule is very small. The old idea concerning cloud globules, that they were hollow vesicles and therefore floated, is quite erroneous. They do not float, they sink. Slowly sinking particles, then, constitute dust, whether these particles be solid or liquid. Water dust is so important that it has various names, such as mist, fog, rain, cloud, and, in popular usage, steam.

Having now stated what dust is, the question presents itself, How did it get there? What are the sources of dust? There are certain human sources of dust—such as the traffic of towns, and the smoke of imperfect combustion. These produce coarse and heavy particles which never rise to a great height, nor float very far from their source: this dust may be regarded as mere dirt and filth. Besides this, however, a fine impalpable dust is produced by every terrestrial activity. The wind blowing through trees, the waves tossing up spray—all these natural activities disperse into the air very fine particles, which are upborne and carried so far from their source that they form quite a permanent part of the atmosphere. This fine natural dust is not limited to the lower atmospheric levels, but is almost equally abundant at great heights; to it we owe the blueness of the sky, and by it clouds and mists are rendered possible.

Another source of dust is found in volcanoes. During an eruption immense torrents of pumice and ashes are driven upwards to incredible heights, whence they slowly settle down again, the larger fragments sometimes covering the sea for acres with a thick floating deposit through which steamers slowly crunch their way, almost as if steering through land (see a graphic account in NATURE, signed Stanley M. Rendall, forwarded by Prof. Turner, vol. xxx. p. 288, July 24, 1884; see also vol. xxix. p. 375, abstract of paper by Capt. Vereker); the finer particles being carried hundreds of miles away from their source, and giving rise to brilliant appearances as they catch the solar rays—appearances recently observed over a great part of the world at sunset.

Yet another variety of dust is that which comes to us from ultra-terrestrial sources, fragments of interplanetary matter, cosmic or meteoric dust. You all know of the showers of falling stones—the August and November meteors; you know that these are lumps of interplanetary matter careering through space, mostly doubtless round the sun, but not aggregated together into planets. Cold lumps of iron they mostly seem to be, possibly fragments of some ancient world, possibly relics of the old nebulous world material, never yet aggregated into worlds at all. For ages they may have been rushing along, some almost isolated, others crowded together, and so they might rush on for millions of years; but a larger body bears down upon some of them; they feel the gravitative influence of the huge mass of a planet; they are deflected from their course notwithstanding their prodigious speed, and a few dip into its atmosphere. In an instant the terrific friction strips off their outer coat, scrapes and rubs the surface till it glows with a white heat; streams of white-hot particles are still scraped off, and form a luminous trail, but the white-hot masses plunge on: and one perhaps escapes to resume its wanderings, disturbed a little by its encounter but not destroyed; another may be rubbed to fragments altogether; another may be heated so rapidly and unequally as to explode; while another may enter the atmosphere at a more moderate velocity—may be heated indeed, and violently scraped, but not destroyed, and may embed itself in the ground, to be dug up by some peasant as a thunderbolt and to be preserved in some museum. The frayed particles of such meteors must constitute no inconsiderable portion of terrestrial dust; and since it comes from altogether extra-terrestrial sources, it is to us of most intense interest. One other visitant from other worlds we know of, and that is light. Light is found to be charged with information, though it took man many centuries to learn how to read it—first with the telescope, now with the spectroscope, and next with who shall say what still more potent revealer and analyser of hidden truth. Meteoric dust may not be so laden with informamation as light is—certainly we have not yet learnt to read it. It is only within the last few years that, at the instigation of Sir William Thomson, a Committee of Section A of the British Association was appointed to consider the question whether such dust could be collected and detected at all. Under the able and energetic guidance of Dr. Schuster, this Committee has done good work, and some dust from the ice-fields of the Himalayas

and from Greenland has been definitely proved to be meteoric.

At present however no sign of organic matter or evidence of extra-terrestrial life has yet been detected in it, but any year this statement may have to be modified, and a discovery of the most intense interest may have to be announced. You have probably all heard of this theory of Sir William Thomson's, that some life germs may have been carried to the earth by a meteor, and you are probably equally well acquainted with the cheap ridicule the statement met with at the hands of newspaper article writers and the general public. It was derided as an absurd attempt to explain the origin of life. It was nothing of the kind. Nothing at all was said about the origin of life; it was a sober matter-of-fact statement that it was a scientific possibility for some organic germs or seeds to be conveyed to the earth by a meteor, to be rubbed off it at its first entrance into the atmosphere without getting overheated, and thence to slowly settle down as dust, and germinate. Well, it is a possibility, and it may before now have happened, and it may happen again, and very interesting it would be to be able to point to a case of its happening. But what then? If you account for the presence of a cherry-tree in your orchard by saying that it sprang from a cherry-stone dropped by a passing balloon, are you to be assailed as a full-blown explainer of the origin of all cherry-trees and of all forms of life?

You may take it as a fairly safe rule that when a statement is made by the highest living scientific authority, the statement may or may not be true, but it is not likely to be such abject nonsense that any newspaper article writer, in the interval between ten o'clock and midnight, can see all through it, detect its follies, and serve them up exposed for your breakfast edification.

Leaving the subject of meteoric dust now, and of the possibility of future discovery which may be wrapped up in it, let us proceed to ask, What is dust for—what purpose does it serve? We shall not enter upon the teleological inquiry, what was it intended to do; we shall simply ask what it does—a plainer, and for the most part a more instructive, question.

First, what is the function of human dust, such as is made in towns? One of its functions is to choke up the breathing organs both of plants and animals; another is to propagate disease from place to place. It is one of the most important discoveries of this century, that infectious disease is due to the growth of a specific vegetable organism in the system, propagating itself like yeast in dough, or ferments in alcoholic liquors. The germs of these organisms float about in the air from place to place, and gain positions enabling them to enter the blood of some animal organism, say man, where they can grow and flourish, provided they are able to successfully encounter their mortal foes, the white corpuscles of the blood. If these white corpuscles are strong and vigorous, they will overpower the foreign growth, and kill it. If, on the other hand, they are weak and feeble, and the germs are very numerous, the foreign growth may get a secure footing and spread luxuriantly, changing the character of the fluids of the body, coagulating, it may be, the albumen, and otherwise setting up the unnatural and abnormal display of functions which we call disease. I have only to indicate thus much to exhibit to you the enormous field of knowledge and of inquiry which is involved in the discussion of the function of dust from this point of view.

But it is not my province to discuss this, and I must hasten on to more purely physical considerations, and must ask, What is the function of the fine impalpable dust or ultra-microscopic particles in the upper regions of the air? First of all, it is this which causes the blue of the sky and the diffusedness of daylight. I have not time to go into this. I will only state it, and pass on. You will find the rudiments of it beautifully expressed by Dr. Tyndall in his Lectures on Light, but it will take Lord Rayleigh to explain it to you completely.[1]

If the atmosphere were purely gaseous, and held no minute foreign bodies in suspension, the aspect of the sky would be utterly different from what it now is. The sun would glare down directly with blinding intensity, and objects not in direct sunlight would be in almost complete shadow. A room facing north would be in something like darkness: at least, it would be only illuminated by reflection from illuminated objects outside. The sun would be set in a black firmament, and if its direct light were screened off it would be easy to see the stars at noonday. (Through dust-free air light passes on without loss by scattering, and is quite invisible except to any eye placed directly in its course. [Tyndall's optically empty tube was here shown.] There is nothing remarkable in seeing nothing, when no dust or other reflecting body is present. When you see motes dancing in a sunbeam, it is not the motes which render the sunbeam visible, but the sunbeam the motes; and of course light is invisible which does not enter the eye.)

What is the actual state of things as contrasted with this? The sun's rays on reaching our atmosphere are partially intercepted, diffused, and scattered by myriads of most minute particles, so minute as to be even smaller than the light-waves themselves, and to act on the smallest of these waves more powerfully than on the largest. The light thus scattered is the diffuse daylight so entirely satisfactory and pleasant to the eye, and so inimitable by artificial systems of illumination. The light thus scattered has a preponderance of small waves, owing to the minute size of the scattering particles, and hence it affects our sight organ with the sensation of blue. By this scattered light shadows are mellowed, the intensity of direct sunlight is mitigated, and the whole expanse of sky glows with a perfect lustre, effectually drowning the light from the more distant celestial bodies. Above the top of a high mountain dust is almost absent, and there the sky has been observed at times to look almost black, and stars are sometimes visible in sunlight.

But besides the blue of the sky, we owe to this dust the possibility of clouds, which still further intercept and scatter the solar beams. "Cloud is visible vapour of water floating at a certain height in the air," says Mr. Ruskin[2]; but he is not quite right in his language. True vapour of water is invisible, and that which is visible is no longer vapour, but condensed vapour. It is vapour which has condensed to liquid—not to great masses of liquid, but to minute globules or spherules of liquid, so small as only to sink very slowly through the air. What makes the vapour condense into this water-dust form? Why does it not condense at once into great masses or sheets of water? Something there must be to start the condensation at multitudes of separate points, so that the vapour shall condense the instant it is saturated, without ever becoming supersaturated. Things that act in this way are called nuclei. Without a nucleus, it is as easy for a phenomenon to begin at one place as at another, and when that is the case it does not begin anywhere: there is no preponderating cause. Wherever there is a nucleus, however, there the action can begin; and in order that action may commence at an infinity of points at once, it is necessary that an infinity of nuclei exist. The action of nuclei is readily illustrated by the well-known experiment of a supersaturated solution of Glauber's salts. The solution remains liquid until a nucleus is introduced, when it becomes suddenly converted into a solid. (I don't say that it is clear *why* nuclei are able to start the action. What is there at the surface of discontinuity to make change of state easier there than anywhere else? It will take a bigger man than me to tell you that.[3])

[1] *Phil. Mag.*, August 1881. [2] "Storm Cloud" lecture, p. 12.

[3] Sir W. Thomson has partially indicated a reason for it in his theory of the effect of curvature of surface on vapour-tension. See Maxwell's "Heat," chap. xx. p. 268.

Now this sudden conversion is just what might happen in the case of the atmosphere, only the change of state would be from vapour to liquid. Picture to yourselves aqueous vapour accumulating and increasing in quantity in dust-free air, saturated, over-saturated, nothing to start the condensation; it goes on accumulating; the atmosphere becomes unbearably damp, soaking into and through everything. At length at some point something causes it to give way, and condensation takes place. Instantly it spreads from this point as from a centre, volumes of liquid are produced, and fall not as a shower but as a splash, deadly and destructive by the mere weight and impetus of its fall.

Instead of this, what really happens? The moisture, on becoming saturated, finds myriads of minute dust particles or nuclei, round which it condenses; the more numerous the nuclei, the more minute may be the globules of mist formed; it never becomes supersaturated at all. The instant it is saturated it begins to condense, and we have the mist or visible cloud, and in this form it may last for any length of time. Under certain influences, however, not yet fully understood, but which I wish in part to illustrate to-day, these minute globules may congregate into larger ones. Too large to remain slowly falling through the air, they begin to fall more quickly as their size increases, and we get the fine shower; or, if the aggregation goes on further, and the drops do not evaporate much as they fall, we have the heavy downpour, the thunderstorm, or the tropical deluge—all varieties of rainfall caused by the different size of the aggregated water globules.

Were there no nuclei, condensation would not begin, and were there but few nuclei, condensation could only begin at a few points, and a quite different kind of mist might present itself; one which would consist of comparatively large and rapidly sinking globules—small for raindrops, but large for mist globules, a kind intermediate between mist and rain, such a mist as is met with in clear moist climates, and known in England as a Scotch mist.

Note this, that to get a fine permanent fog, you must have an enormous number of centres of condensation. Mr. Aitken (*Trans. Roy. Soc. Edin.*, about 1879) established this fact, that every spherule of mist must have condensed itself round a minute solid dust particle, a nucleus, and that without such nuclei condensation could not go on. The minuteness of the nuclei able to act in this way is extreme, an almost immeasurably small quantity of matter being sufficient to precipitate a copious cloud. Their size is quite beyond a microscope.

[Mr. Aitken's experiment was here shown with apparatus from the Royal Institution. A long glass tube is filled with moist air, carefully filtered through cotton wool and glycerine, after Tyndall, and is then suddenly exhausted by an air-pump. It is thus cooled far below the dew point, but no precipitation occurs; and the tube, well illuminated, is seen to remain clear. Now ignite a platinum wire inside it with a few Grove cells, and let more filtered air enter. As soon as this is done exhaust again; instantly a thick cloud is precipitated, condensation occurring round myriads of nuclei given off from the platinum wire—which, however, has not appreciably lost weight. I wonder if this experiment could not give Sir Wm. Thomson a fifth limit to the size of atoms by estimating the loss of weight of the platinum spiral and the number of globules in the resulting mist.]

A familar illustration of the effect of nuclei on vapour is given by the simple experiment of writing on a pane of glass with a stick, and then breathing on it. Where the writing has wiped away the dust, the moisture condenses less easily and in much fewer and larger globules than where nuclei are abundant; consequently the writing becomes visible.

In studying the properties of any physical agent, it is essential to be able to employ it or exclude it at pleasure. One must have insulators to investigate electricity; one must perform optical experiments in a dark room; and to study the properties and functions of dust it is important to be able to remove it, and to obtain dust-free spaces.

Methods of removing dust from air are:—

(1) Filtration through cotton-wool, or cotton-wool and glycerine, packed tightly. Tyndall has shown how effective this can be made with proper management.

(2) Allowing it to settle. In a few days or a week most of the dust has settled out of stagnant air. Prof. Noel Hartley employed atmospheres of hydrogen in his old and careful experiments on "spontaneous generation," because it was too rare for germs to float in.

(3) Condensing vapour in the air several times. Mr. Aitken has shown that successive condensations of vapour gradually purify air by removal of nuclei, until it is quite clear. He shows that the ability of vapour to condense is an extremely delicate test of the presence of such nuclei, and that when the dust particles are very few, condensation takes place not as cloud but as fine rain or Scotch mist. Doubtless, the cause of actual Scotch mist is the clearness and purity of the Highland air induced by frequent and continued rains.

(4) Keeping a hot body in air for some time. This, Tyndall calls "calcining" the air.

(5) Discharging electricity into it from a point.

I must say a few words about the two last methods. When a hot body is held under a sunbeam, a dark stream of dust-free air is seen rising above it. This was discovered by Dr. Tyndall, and investigated by Lord Rayleigh, as well as by Mr. Clark and myself.[1] A hot spiral of platinum wire in a bell-jar produces this dust-free stream, and so gradually clarifies the air in the jar. That this is not due to combustion or evaporation we proved by using the smoke of burnt magnesium, which answers perfectly. Lord Rayleigh has shown that a cold body is similarly effective, and causes a *descending* dust-free stream.

We have found that the dust-free streamer is only a prolongation of a dust-free *coat* which surrounds all warm bodies. The dust is kept away from them by molecular bombardment. It has been shown by Tait and Dewar, and by Osborne Reynolds, that a Crookes bombardment is effective at even ordinary pressures provided the bodies bombarded are small. Dust particles are very small, and so they get driven by molecular impact away from hot surfaces and towards cold ones: the distance through which they are so driven away being easily measured by observing the thickness of the dust-free coat round an illuminated body at known temperature.[2] Two black tin vessels or glass flasks can be put under a bell-jar, one of the flasks full of warm water, the other of cold. On now burning magnesium, or otherwise filling the jar with smoke, the cold one will presently be found thickly covered with a deposit, the warm one will be nearly free. What Tyndall calls "calcining" the air, then, is really bombarding the dust out of it on to the cool wall surfaces. The deposition of lamp-black on a cold body held in a flame is thus explained. Whenever the air is warmer than bodies it deposits its dust and smoke upon them; whenever bodies are warmer than the air they keep the dust off, except when the weight of some of the larger particles is sufficient to overcome the bombardment; a thing which is very likely to happen on a horizontal and slightly warm surface.

[1] Mr. Aitken commenced the same investigation after reading my preliminary note of July 1883 in NATURE, and has followed it up in much the same way as we have, obtaining very similar results. I have just seen Mr. Aitken's paper in the *Trans. Roy. Soc. Edin.*, vol. xxxii. Part II. He therein criticises one or two of the views I somewhat hastily expressed in the preliminary note referred to. But our views were naturally modified by further experience, and in the complete paper in the *Phil. Mag.*, March 1884, they are more carefully expressed. It would have been better if I had not written to NATURE until the investigation was complete.

[2] See Lodge and Clark, *Phil. Mag.*, March 1884; also NATURE, July 26, 1883, vol. xxviii. p. 297, and April 24, 1884, vol. xxix. p. 612.

So we learn that the things in a room warmed by radiation (sunlight or open fire), because they are warmer than the air of the room, do not tend to get very dusty. But in a room warmed by hot piping or stoves, things are liable to get very dusty because the air is warmer than they are.

Finally, let us turn to electrical phenomena in dusty air. Just as a magnet polarises iron filings, and makes them attract each other and point out the lines of force, so an electrified body polarises dust particles, and makes them point out the lines of electrostatic force. It is therefore very interesting to watch electrical phenomena in illuminated smoky air.

The pyroelectric behaviour of tourmaline for instance is beautifully shown by the aggregation of dust in little bushes at the opposite poles of the crystal. Mica often exhibits strong electrical actions. But perhaps the most curious thing of all is what happens when a brush discharge begins in such air. The violent and tumultuous action must be witnessed—it can hardly be described; but it does not last long, for in a few seconds every particle of dust has disappeared, condensed on the walls and floor of the vessel.

[An experiment of discharging from a point connected with one pole of a Voss machine into a bell-jar of illuminated magnesium smoke was then shown. It is a very easy experiment, and rather a striking one. A potential able to give quarter-inch or even one-tenth-inch spark is ample, and better than a higher one. The smoke particles very quickly aggregate into long filaments which point along the lines of force, and which drop by their own weight when the electrification is removed. A higher potential tears them asunder and drives them against the sides of the jar. A knob polarises the particles as well as a point, but does not clear the air of them so soon. If the bell-jar be filled with steam, electrification rapidly aggregates the globules into Scotch mist and fine rain.[1]]

This experiment shows how quickly air may be cleared of its solid constituents by a continuous electrical discharge. The fact may perhaps admit of practical application in clearing smoke-rooms, or disinfecting hospital air. It also must have a close bearing on the way in which "thunder clears the air," on thunder-showers, and perhaps on rain in general. Sir Wm. Thomson's "effect of curvature on vapour-tension" shows that large cloud globules increase at the expense of small ones, and so may gradually grow into raindrops; but under electrical influence rapid aggregation of drops must occur. The large drops so formed may be upheld by the electrical attraction of a strongly charged thunder-cloud, but as soon as the flash occurs, down they must come. Lord Rayleigh made some interesting observations on the effect of a feeble electrical charge in inducing a spreading water-jet to gather itself together (*Proc. Roy. Soc.*, No. 221, 1882); and Prof. Tait has pointed out in his lecture on Thunderstorms (NATURE, vol. xxii. pp. 339, 436) that aggregation of feebly charged drops into larger ones is of itself sufficient to raise their potential. One strongly charged cloud would thus act on another, aggregating its drops, and so raising its potential until a flash is a necessity.[2]

It seems not impossible that some use may be made of this aggregating power of electricity on small bodies, such as smoke particles and mist globules. In coming to this country we lay for some hours outside the Straits of Belle Isle in the midst of icebergs mingled with fog. Icebergs alone are not dangerous but beautiful. Fog is an unmitigated nuisance. Electric light is powerless to penetrate it; and it was impossible, as we lay there idle, not to be struck with the advisability of dissipating it. It is rash to predict what can be done, it is still rasher to predict what can not. I would merely point out that on board a steamer are donkey-engines, and that these engines can drive a very powerful Holtz or Wimshurst machine, one pole of which may be led to points on the masts. When electricity is discharged into fog on a small scale, it coagulates into globules and falls as rain—perhaps it will on a large scale too. Oil stills the ripples of a pond, and it has an effect on ocean billows; just so an electric discharge, which certainly coagulates and precipitates smoke or steam in a bell-jar, may possibly have an effect on an Atlantic fog. I am not too sanguine, but it would not cost much to try, and even if it only kept a fairly clear space near the ship, it would be useful. There are other possible applications of this electrical clearing or deposition of dust, but I am not here to talk of practical applications but of science itself. A homely proverb may be paraphrased into a useful motto for young investigators. Stick to the pure science and the applications will take care of themselves. I am not one to decry the applications of science for the benefit of mankind, far from it, but while the rewards of industrial applications are obvious and material, and such as will always secure an adequate following, the rewards of the pursuit of science for its own sake are transcendental and immaterial, and not to be imagined except by the few called to the work. That call entails labour and self-sacrifice beyond most other, but they who receive it will neglect it at their peril.

[1] I find that unless one claims a lecture experiment it is commonly treated as a *rechauffée*. It is pardonable, therefore, and indeed only due to Mr. Clark, who has been associated with me in the dust research, to state that these observations are original. A small cellar can be cleared of thick turpentine smoke pretty quickly by a point discharge.

[2] If the initial potential of the second cloud were opposite to that of the first, the spark would pass between the two clouds: if it were similar, its rise would raise the potential of the first cloud, and so cause it to spark into something else.

HEREDITARY DEAFNESS[1]

THE startling title of Mr. Graham Bell's admirable memoir is fully justified by its contents. It appears that there are upwards of 33,000 deaf mutes in America, mostly collected in large institutions forming social worlds of their own, whose inmates intermarry or else contract marriages with the hearing relatives of their fellow pupils, who themselves, in many cases, must have an hereditary though latent tendency to deafness. This state of things has been going on increasingly for two or more generations, with the result that congenital deafness, which in other countries appears sporadically, and mostly fails to obtain an hereditary footing, has become artificially preserved in America, and is intensified by inter-marriages, until a deaf variety of the human race may be said to be established. There can be no question, after reading the mass of evidence submitted by Mr. Graham Bell, of the general truth of this summary statement. That precise knowledge that we should be glad to possess, of the strength and peculiarity of the hereditary taint, is unfortunately unattainable owing to the imperfection of the records kept at the institutions of the after history of their pupils; but the data, such as they are, have been handled with great statistical skill by the author, so that he has squeezed all the information out of them that they appear competent to give.

We may now go a little more into details. It appears that out of six asylums, with an aggregate of 5823 pupils, 29·5 per cent. have deaf relatives. Also that nearly half the pupils contract marriages, and that 80 per cent. of those who do so, marry together. This ratio of intermarriage is much greater than it was at the beginning of the century, and it appears to have steadily increased from then up to the present time. It is unfortunate that the imperfection of the records kept at the institutions make it difficult to ascertain the exact rate of the increase or the precise fate of the issue of all the marriages. This latter fact may, however, be estimated by working back-

[1] "Upon the Formation of a Deaf Variety of the Human Race," by Alexander Graham Bell, National Academy of Sciences, New Haven, U.S.A., November 13, 1883.

wards, and finding the number of deaf-mutes known to exist among the ancestors of the present inmates of the asylums. The family history of many of these is appalling, such as "Grandfather, father, mother, and other relatives"; "father, mother, one brother, and five uncles and aunts"; two cases of "father, mother, one sister, one uncle, and one aunt"; two cases of "father, mother, two brothers, and two uncles," and so on. In one case as many as fifteen deaf-mute relatives are recorded. Genealogical trees are given of the families in which deaf-mutism prevails, and the large proportion of the members of those families who are congenitally afflicted is most painfully illustrated. The surnames of the inmates of deaf-mute asylums are analysed, and the frequency is pointed out of the recurrence of many strange-sounding names, such as "Fahy," "Hulett," "Closson," "Brasher," "Copher," "Gortschalg," &c., apparently out of all proportion to the number of persons bearing those names in the general population.

The influences that promote the inter-marriage of deaf-mutes are fully described. The isolation of their class from the rest of the world is becoming more and more complete. Each institution is a self-sufficing *alma mater* where every member feels really at home, and with which each member continues his connection in after years. Gatherings of old pupils of both sexes, *conversaziones*, and other social meetings are of frequent recurrence, and what is most important of all, the highly-developed and very conventional gesture language of the deaf and dumb has already moulded them into a distinct nation. They think not in words, but in abbreviated symbolic gestures, and the sequence and association of their ideas is thus compelled to be idiomatic and widely different from those of the rest of their race. English and other spoken languages are foreign tongues to them, and are acquired, for the most part, very imperfectly. A separate mode of life is so congenial to persons reared under such exceptional surroundings, and of such exceptional natures, that unwise schemes have been from time to proposed, of buying land in settlements for the deaf and dumb, where they should reside and form a secluded society of their own. They are content with their lot when they are brought into contact with none but themselves, but they are ill at ease, and feel themselves to be aliens, when they are forced into the presence of the outside world. What wonder that they should shrink from it, and intermarry and strive to keep apart.

The interest of this strange story is twofold. In the first place it shows how easily a marked and degenerate variety of mankind may be established in permanence by a system of selection extending through two or three generations; and, secondly, it is an instance in which strong social, and possibly legislative, agencies are sure to become aroused against unions that are likely to have hereditary effects harmful to the nation. The advisability of various forms of restrictive measures is judiciously and carefully discussed by the author, with the general result that gesture-language should cease to be taught, the oral system being enforced in its place, and that the philanthropic custom of massing the deaf and dumb together in separate societies, and of making their life as happy as possible in those societies, should be strongly discouraged.

Instructive experiments on the rate at which a deaf breed of animals could be formed, might be made by breeding deaf cats, who are by no means inefficient mousers, and who show no signs of discontent at their lot. I may mention an observation of my own as having some possible pathological bearings. It was this: during a country walk I lunched at a roadside inn, where I saw a female cat with blue eyes, and asked and found that she was quite deaf, but was told that her kittens all heard perfectly. The only one of them that had been kept was in the room, and she certainly noticed my voice and other noises I made to attract her attention, just as readily as other kittens. Then it occurred to me to try her with the shrill notes of one of my little whistles, which I had in my pocket-book. She was absolutely deaf to these, and I doubt if she could have heard a note as shrill even as the chirp of a sparrow. Cats, as I have elsewhere observed, are eminently sensitive to shrill notes, so that the deafness of this kitten was a noteworthy proof that the imperfect stages of the form of hereditary deafness to which she was subject consisted in the degeneration of that part of the auditory apparatus which is concerned in hearing shrill notes. I am told that no thorough anatomical investigation has yet been made into these matters, owing to insufficiency of subjects. It would therefore seem that a breed of deaf cats might be very acceptable to physiologists, and I have no doubt that such a breed might be easily established on any small and sparsely-inhabited island from which every hearing cat had been removed. Cats will not breed in strict confinement, and their roving habits at night make it impossible, under ordinary circumstances, to keep their breed pure; but in small islands, under the paternal despotism of a popular landlord, this and many analogous experiments in breeding varieties of small and hardy animals and plants, such, I mean, as would take care of themselves, might be carried out. I have often envied the facilities afforded to such projects by the geographical and social condition of the Scilly Islands.

FRANCIS GALTON

ASTRONOMICAL TELESCOPES FOR PHOTOGRAPHY[1]

II.

THE simplest form of the reflecting telescope is that in which only one reflecting surface is used, known as the Herschelian, or, as Sir John Herschel, in his work, "The Telescope," calls it, "the Simple Reflector." The remarks he makes on this form are well worth most careful consideration in connection with the use of the reflecting telescope for photography.

All other forms have the second or third mirror only for the purpose of bringing the image formed by the large mirror where it can be more conveniently used. Of these the Newtonian is the simplest and perhaps the best, as here the second reflection does not alter the size of the image, but only diverts it to the side of the tube. In the Cassegrain or Gregorian form the use of the convex or concave mirror enlarges the primary image more or less. Modifications of the Cassegrain form can be made by replacing the small convex mirror by a flat or very slightly curved mirror, in which case, although there is much loss of light, the image is kept nearly the same size as in the Newtonian. There is also the "Brachy" form, where the Cassegrain is used obliquely, but this is practically a Cassegrain. In all these telescopes, except the first and last-mentioned, the second mirror requires support of a kind that acts most injuriously on the image, causing rays to come from stars which, in the case of stars as faint as eight magnitude, show quite distinctly with such long exposures as are needed in photographing the nebulæ or clusters of very faint stars. In addition to these well-known forms of the reflecting telescope there is the arrangement of three reflectors as a telescope indicated by me in the May number of the *Monthly Notices* of the Royal Astronomical Society, and also the application of the Coudé principle, treated of at length by M. Lœwy in the June number of the *Bulletin Astronomique* (1884). As far as I know there has not been any practical application of the Coudé principle to the reflector. The need of three reflections would involve great loss of light, and for this reason alone would render it unsuitable for photo-

[1] Continued from p. 40.

graphy where so much depends on the power of the telescope to bring together as much light as possible on the surface of the sensitive plate. Apart from this great loss of light there would be enormous difficulties in making such a telescope of even three-foot aperture, indeed, I am very doubtful if it could be done, there is the difficulty of keeping the different mirrors free from flexure and in proper adjustment, there is the fact that the form of mounting that must be used to carry the ponderous mirrors would be that most unfavourable to the good performance of the whole as a telescope in regard to the atmospheric disturbance due to the mounting; and last, though not least, the position of the external plane mirror would be so exposed that it would not stand many nights' work; with the flat mirrors of a Newtonian telescope one has much difficulty, as a slight rise in temperature will dew them at once, and under ordinary circumstances they become very soon so dull that they require re-silvering many times more frequently than the large mirror. Certainly the large plane mirror would conserve its heat better than the small flat of a Newtonian, but from the exposed position it would occupy, it would certainly be a source of continual trouble. There is only one good thing in such arrangements, and that is that the observer has not to follow the eye-piece, which only rotates, and does not change its position. For general observational work this becomes of importance. For comet-seeking, for which I believe this telescope was first used, it is difficult to imagine a more suitable arrangement than that brought again to the notice of astronomers by M. Hermite in *L'Astronomie*, October 1884, though his proposition, to dispense with a tube or to use a fixed one, would make a difficulty at the eye-end, where the image would rotate, as it would in the case of a fixed telescope with a mirror moving in front, after the manner of a siderostat. For photography all those latter forms of telescope are not admissible; even for large fields, when a refractor specially made was used, it would be better to use it as a simple equatorial than to lose the light by two additional reflections. Considering carefully the different reflecting telescopes enumerated above, there does not appear to be anything that can be more simple than the Herschelian, and nothing more suitable, judging from what has been done, than the Newtonian; nor does there seem anything in any other form that offers greater advantages than these, either on the grounds of simplicity, easy manipulation, possible increase of size, and, what is of vital importance, smallness of first cost; it is on one or the other that I should entirely rely as the photographic telescope of the future; whether the Herschelian form would be better in practical use than the Newtonian, or, rather, whether the reflecting surface could be made as good in this case, would only be shown by actual trial; if it could then, for the reason already mentioned, the image would be the best, and the best kind of telescope for the purpose of photography would be found.

In the Newtonian, as has been said, the plane mirror is only used to bring the rays, that would form the image otherwise in the centre of the tube, out at the side, but as the object is not to be viewed, but photographed, the plate can be placed in the proper place to receive those images direct from the large mirror, as was done by Dr. De la Rue when he first used the reflecting telescope for photographs of the moon.

There are some difficulties in getting a proper supervision of the exposure, but these are not insuperable. A mounting for the Newtonian reflector pure and simple would be equally suitable for the Herschelian, so that if it were decided to make a large telescope, no danger would be run that success would not be certain; if the Herschelian gave such excellent results, as I think might be fairly expected, so much the better, if it did not, the telescope that has already shown its capacity would simply remain what it is now—the only telescope suitable for photography on such a scale as can be really useful.

As to the way in which such a telescope as I here contemplate, that is, a reflector of from 5 to 8 feet aperture, should be mounted, there would be a certain safety in following the plan I have found so good with 3 foot, with such mechanical alterations as the use of water in place of mercury for the floating medium would render necessary. The general principles, I believe, are correct as regards the conditions that affect the performance of the telescope as an optical instrument.

The duty of the observer would now be entirely limited to seeing that the image fell always on the same place on the plate during exposure, a duty that is easily described, but not so easily done. For this purpose he must have such optical arrangements that he can from the ground watch the position of the image of a star anywhere near the object to be photographed in its relation to a cross wire attached to and moving with the sensitive plate, so that if, from the many causes that can produce a shift of this star and of the image on the plate, there is a slight movement, he can at once correct it. The telescope would work entirely in the open air under the most favourable conditions and without any disturbance from the body of the observer, as he would not be near the high end of tube. The large mirror would be protected from dew by a slight covering round the skeleton tube, and have an apparatus to cover it up quickly, and so be in the best condition to keep its polish, and with the absence of a small mirror and its trouble at the high end of the tube, simplicity would be followed to its fullest extent without the sacrifice of one essential point.

Such a telescope would be capable of giving photographs of all the nebulæ, with exposures of from 30 to 60 minutes, of the various clusters, and of certain selected parts of the heavens, and this should be for some years its chief work. About the value of such a work it is quite unnecessary to speak—to show that it can be done is quite enough.

In thus giving my opinion as to the best kind of telescope to use for this most important part of astronomical photography I place it first for its importance. That much could be done by a smaller instrument, or, rather, by many smaller instruments, of a most valuable character, I have not any doubt. It is quite possible now, by means of photographic lenses, to take stellar photographs that are of great value; and any equatorial reflector, and many refractors, if they have driving apparatus of fair quality, could be most usefully employed in photography, and that without any more knowledge of the art of photography than could be learnt in a few minutes; by taking photographs of a small portion of the sky that could be identified, and working entirely at that, the amateur astronomer, with any aperture over 6 or 8 inches, could make a monograph that would be good for all time, and his results would not be the mere expressions of impressions on his mind through his eye, but would be visible ones that would speak for themselves as to their value. In all departments of stellar photography, excepting of course absolute positions, I think that photography is at once available. It is remarkable that the silver-on-glass reflector has proved itself to be capable of practically unlimited increase in size and to be so well fitted for photography at the same time that the photographic process has been brought to such a state of perfection, especially in this country, the home, if not the birthplace, of the reflector. At the present moment a gigantic stride in advance is to be made with certainty of success, and that at a cost that is insignificant compared to the results that must come. Let us hope some one who can hasten this step will come forward; if one cannot, many must, for it should not be delayed.

A. Ainslie Common

SOME EXPERIMENTS ON FLAME

IN December 1881 my attention was casually called to the popular superstition that sunlight puts the fire out. Returning from a walk I had found the blinds of my sitting-room closely drawn, for the benefit, as I was told, of the fire, which was low. On my appearing somewhat sceptical about the use of this proceeding, my landlady cited the above-mentioned superstition as a well-known fact. For her benefit and instruction I made the poker red hot, and focused the sun's rays on it with a bull's-eye, showing her that, though the bright light prevented the red heat from being seen, it had not extinguished it, and was, moreover, capable of making a smaller piece of metal red hot. But I was myself so struck with the power of even the December sun in overcoming the light of the most highly incandescent body, that I determined to make further experiments. Even the intense glow produced by heating in the blowpipe flame a small piece of chalk, though it was sufficient to light up the whole room, entirely disappeared in the sun's rays. This led me to ask what would be the result of testing the sun's light in the same way against that of a flame. If, according to the older theory, luminous flame consists of incandescent solid particles, then I should expect that these would behave under the strong light exactly as the white-hot iron did, while, on the other hand, if as some have maintained the white light of a flame proceeds from gases of great vapour-density, then I might expect results which, if not different, would be at least interesting.

Experiment 1.—Accordingly, on December 7, 1881, I arranged my large condenser—a lens 5 inches in diameter, and 20 inches focus—so as to throw the image of the sun upon the flame of a paraffin candle. To my delight a round spot of light of a bluish-white colour and peculiar soft appearance was visible on the flame itself. That the flame, whether gaseous or consisting of incandescent particles, could reflect light, was certain. It remained for me to determine the characteristics of this reflection. From its colour and peculiarly "soft" appearance it reminded me of fluorescence. I therefore proceeded to test the question with the spectroscope.

Experiment 2.—I examined first the spectra given when a beaker of petroleum or one of solution of quinine sulphate was placed in the focus. I should mention that my spectroscope, which I designed and made myself, slides up and down the supporting pillar, so that it can be adjusted to any height. The table carrying the slit, and telescope, and prism (dense flint of 60°), can be fixed in three positions to the stand, so that the slit may be vertical, horizontal, or directed vertically downwards for examining solutions with the light thrown up from beneath. It is also provided with a doublet, equivalent to the B eye-piece of a microscope, used as a condenser to throw the image, which may be an enlarged or diminished one at pleasure, of any object upon the slit. The whole arrangement is very simple, and far more convenient than that of the ordinary laboratory spectroscope. Bringing the instrument thus armed to bear upon the strongly illuminated solution, I found the field of view to be filled with a soft and even light, that seemed to obscure the Frauenhofer lines as if some thickened luminous solution had been poured over them. Every moment some particle of dust floating into the focus would cause a tiny flash as its image crossed the slit, of hard clear light, like that of the candle-flame, only that it showed the Frauenhofer lines. But after filtering the solution, carefully cleaning the beaker, and excluding all extraneous light, the Frauenhofer lines vanished, and nothing was visible either with quinine or petroleum but the soft continuous spectrum of fluorescence. I have described these well-known phenomena thus minutely that I may emphasise the very different results obtained in the following experiment. To the naked eye the spot of sunlight upon the candle-flame was of exactly the same soft quality, and nearly the same colour as that upon the fluorescent solution. I replaced the candle in the focus, arranged the condenser of the spectroscope so that the white spot should come upon the centre of the slit, and occupy one-third of it. The field of view was filled by the spectrum of the flame, but across the centre was a bright band of light extending far into the violet, brightest in the blue, and showing *all the Frauenhofer lines distinctly*, especially in the blue and violet. Unmistakably I was dealing with reflected light, and not with fluorescence. My thoughts at once reverted to Prof. Tyndall's "blue cloud." I knew of two ways of producing an extremely fine precipitate showing the same characteristic phenomena. I added dilute hydrochloric acid to a weak solution of sodium hyposulphite, but this preparation I found to be troublesome from the rapidity with which it loses its optical properties, so I discarded it in favour of the following. I diluted some French polish with about fifty times its bulk of methylated spirit, and added a few drops of the solution

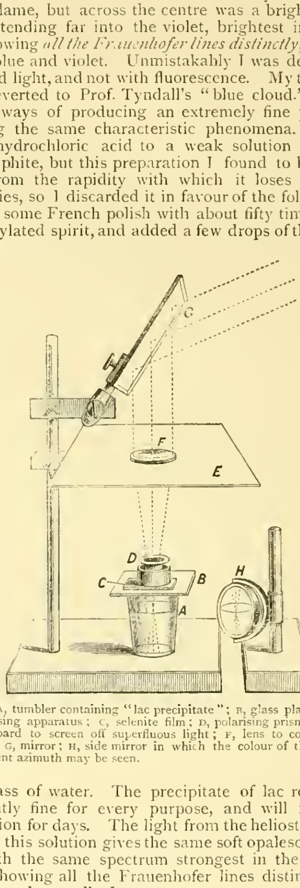


FIG. 1.—A, tumbler containing "lac precipitate"; B, glass plate to support polarising apparatus; C, selenite film; D, polarising prism; E, sheet of cardboard to screen off superfluous light; F, lens to concentrate the light; G, mirror; H, side mirror in which the colour of the beam in a different azimuth may be seen.

to a glass of water. The precipitate of lac resulting is sufficiently fine for every purpose, and will remain in suspension for days. The light from the heliostat passing through this solution gives the same soft opalescent reflection, with the same spectrum strongest in the blue and violet, showing all the Frauenhofer lines distinctly, as it does upon the candle-flame.

Experiment 3.—There is another special characteristic of matter in extremely fine division common to Prof. Tyndall's "blue cloud" and the above-mentioned solutions. Light reflected from it is completely polarised in the plane at right angles to the line of incidence. I am in the habit of showing this by the following arrangement, which I believe to be new, and which is so simple that any one can exhibit it. It is shown in Fig. 1. A is an ordinary plain tumbler, half filled with "lac precipitate," and covered with a piece of window-glass, B. On B is laid a mounted selenite film, C, and upon this again the polarising prism D, used with the microscope. A retort-stand supports a sheet of cardboard, E, with a hole in the centre, which shades the liquid from superfluous light.

and also carries a lens, F, which may be an ordinary eye-glass laid across the hole, and so adjusted that its focus shall come about the middle of the liquid. A plane mirror, G—a hand-glass will do—is then either held or fixed, so as to reflect sunlight perpendicularly upon the lens. It will readily be seen that the light, concentrated by the lens, is plane-polarised by the Nicol prism, then modified by the selenite, and finally analysed by reflection from the extremely minute particles of lac. Accordingly, to a person walking round the table with his eye on a level with the tumbler, the vertical beam of light in the liquid appears to change colour four times. Thus, if the selenite and Nicol are so adjusted that viewed from the west it appears blue, then from the south it will be yellow, from the east blue, and from the north yellow again. If then the selenite be removed from under the Nicol, from both west and east it will be seen as a bluish-white beam of light, while from the north and south it will be invisible altogether, as though a screen had been placed over the lens. By arranging or holding a small mirror, H, at an angle of 45°, by the side of the tumbler, the observer may see the blue colour of the beam from the west side, on which he stands, while at the same time the mirror shows him that its colour, when viewed from the north or south, is yellow. Or three mirrors may be arranged so that all four aspects of the beam may be observed at once. I do not know a more beautiful and striking way of demonstrating the properties of the polarised ray.

Experiment 4.—I now come to the most interesting of my experiments. This polarisation of all light reflected at right angles to the line of incidence is, I believe, accepted as the special characteristic of very finely-divided solid matter. I applied the test to the light upon the candle-flame. I held the Nicol in the plane at right angles to the mean path of the rays, looked through it at the soft spot of reflected sunlight, and rotated it. When the crystal crossed the line of incidence at right angles, the spot vanished; when it coincided with it, the spot was brightest. With a selenite film in addition to the Nicol prism the usual change of colour could be seen, the red and green film showing more distinctly than the blue and yellow. By using the Nicol over the eye-piece of the spectroscope I found that every part of the spectrum of the reflected sunlight is polarised alike, showing that the flame behaves with respect to light exactly as a solution containing extremely fine solid particles. I made a large number of experiments with a view to ascertain how far this similarity would hold, and I now proceed to give some of the most important.

Experiment 5.—I arranged the heliostat with the candle-flame in the focus and the spectroscope at right angles to the line of incidence, with the Nicol prism over the eye-piece, and the condenser arranged to focus the "white spot" of sunlight on the slit. I then gradually lowered the candle so as to bring the apex of the flame into the light. There was no break in the appearance of the spectrum on passing from the hot flame to the non-luminous smoke. Low down, the flame reflected only the more refrangible rays, as far as the middle of the green; towards the apex it reflected also the red. All the reflected light was polarised.

Experiment 6.—With the same arrangement as before, I turned the spectroscope so as to have the slit horizontal. I burnt some soda in the Bunsen burner at a little distance, so that the vapour from it came to the candle. The result is depicted in Fig. 2. The continuous spectrum of the inner flame is crossed by the bright sodium lines which project a little distance beyond it on either side to the limits of the outer flame. In the centre is a bright band, the spectrum of the sunlight on the flame, and on this all the Frauenhofer lines, *including the D lines perfectly black*, as in my drawing. It was very curious to see the two ends of the sodium lines standing out bright against the dark background on either side, visible still as bright lines, though faintly, upon the flame itself, up to the band of sunlight, and then strongly reversed by contrast with its greater brilliancy. I believe I am the first who has succeeded in reversing the sodium lines by reflection. It requires a bright sun to do this; otherwise the red end of the spectrum is not strong enough, but I have succeeded in showing it to several friends.

Experiment 7.—With the same arrangement, substituting a spirit-lamp charged with soda for the candle, nothing was visible to the naked eye; the flame seemed

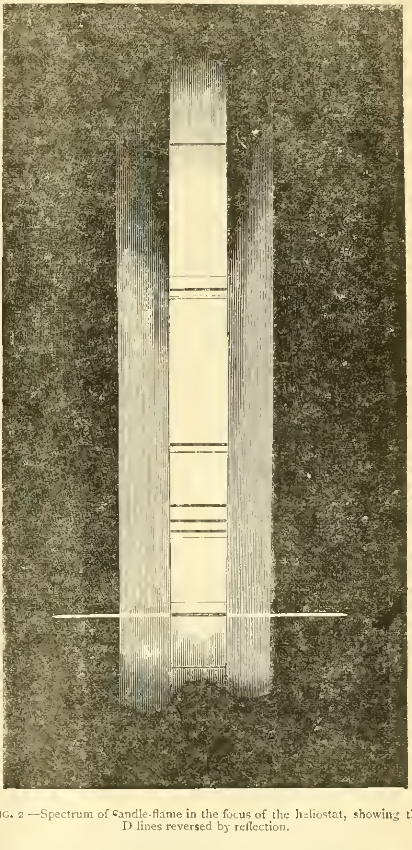


FIG. 2.—Spectrum of candle-flame in the focus of the heliostat, showing the D lines reversed by reflection.

to vanish in the glare; only in the spectroscope the bright lines were seen unaltered. With the Bunsen a brightly illuminated column of dust was seen rushing out of the tube, each particle vanishing as it reached the perfectly invisible flame, and was burnt. Several substances, *e.g.* copper oxide, and ammonium molybdate, give in the outer flame a spectrum which in my small instrument appears continuous, though lacking the "hard" look of the spectrum of an incandescent solid. But they give *no reflection* with the strongest sunlight, behaving as true vapours. It will be observed that, though I have

shown that a substance capable of emitting light of *all* wave-lengths may be capable of reflecting at the same time light of *any* wave-length, yet I have not been able to show whether or not a substance emitting light of one definite wave-length may not be able to reflect light of that same wave-length, though I have proved that it can reflect no other. For instance, the light given by sodium is absent from that of the sun, so that my experiment proves nothing with regard to it; yet that particular light is not transmitted through hot sodium vapour, but is stopped by it. One would think it must either be reflected or its energy must be used up in some way on the vapour itself. I have been unable to get access to the electric light, and no other light I know is strong enough for this experiment. I have wished also to try whether sodium burnt under pressure, or at a very high temperature, would or would not have the power of reflecting light; but in this direction I am again stopped by lack of apparatus.

Experiment 8.—The spectrum of the light transmitted through the lac solution is complementary to that reflected by it, *i.e.* the reflected light is bluish, and the transmitted yellowish-brown; in the latter case the spectrum is weakened towards the violet, and in the former towards the red. I desired to see if this was so with flame. I arranged a metallic screen with a slit one-fourth of an inch long and one-twentieth wide, close to the candle, so that all light falling upon the spectroscope must first have passed through the luminous portion of the flame, and then with a mirror directed the sunlight into the instrument. Pure sunlight was thrown into the upper half of the field for comparison, by means of the reflecting prism. Having adjusted the light so that no difference could be detected between the upper and lower halves of the field of view, the candle was placed in position in front of the slit. There was a very definite general absorption, most noticeable in those rays that are deficient in lamplight, especially about F and G, where also the spectrum of the reflected sunlight is brightest. The experiment is difficult owing to the necessity of reducing the brilliancy of the sunlight without so far reducing the angle of the illuminating ray that the hot air-currents may vitiate the result. But after many trials I satisfied myself that the more refrangible rays of light transmitted through a luminous flame are to some extent absorbed, the effect being stronger in proportion as the smoky part of the flame is approached.

Experiment 9.—It seemed evident that the reflection of the sunlight from the flame was due to its superior intensity; I therefore judged that, if I could lower the temperature of the carbon somewhat, I might get a visible reflection with light from other sources. I held an iron nail in the flame, and focused on the resulting smoke the light from a petroleum lamp. The spot of light was plainly visible, only not of a bluish white as with sunlight, but of a dirty yellow colour. It could be seen not only on the cold smoke, but also where it was of a bright cherry red; beyond that it became lost against the brightness of the incandescence. But the smoke, whether hot or cold, polarised the light exactly as the fine precipitates did.

Experiment 10.—In order to get rid of the disturbing effects of the light from the candle itself, I punched a hole in the middle of a tin plate, and placed it over the candle. The column of smoke coming up through the hole completely polarised the light thrown on it, whether from a lamp or from the sun, at right angles to the line of incidence. I then placed a little tuft of asbestos saturated with melted paraffin upon the hot plate. It gave off a dense smoke, indistinguishable to the eye from that of the burning candle. On applying the spectroscope, however, the difference was manifest. The light reflected by it was *not polarised*. I would therefore suggest that this polarisation test be the distinction between "steam," however dense, and a true "smoke." I have reason to believe that a polarising smoke only arises where the heat causes decomposition.

Experiment 11.—I placed the under side of the tin plate in the light, and found that the soot upon it reflected plane-polarised light in all directions at right angles to the line of incidence.

I now desired to ascertain if this power of reflecting light is confined to substances burning in the inner flame. It is difficult to make accurate observations as to the spectrum of the inner flame with an ordinary Bunsen burner, from the fact that it is completely surrounded by the outer flame; and this last, being but feebly luminous, gives only a very faint spectrum. I wished to make an arrangement by which the spectra of the two flames could be completely separated, while at the same time their intensity should be increased. Accordingly, I made a Bunsen burner with a rectilinear aperture, two inches long by an eighth of an inch wide, in place of the usual round tube. This gave me a broad flat flame, the edges of which I allowed to play each against a piece of well-annealed glass, so that I could look through the glass and see the flame edgeways. In this way I got a very strong spectrum of both the inner and the outer flames, perfectly distinct from each other, the ends of the flame being cut off by playing against the glass. The inner flame with its bright lines was thus completely separated from the outer with its soft, apparently continuous, spectrum: under sufficient pressure, the separation extended to the eighth of an inch or more. I could see no lines across this intervening space, except perhaps that in the violet: as to which I am not quite sure. Of the others I am certain, and I think the space is perfectly dark. As the glasses soon crack, I substituted another arrangement, which I hope still farther to perfect. In this flame I burnt a number of substances, keeping the image of the sun upon it all the while, and having the spectroscope with polarising prism, &c., arranged as in Experiment 5. I here give the results of two of the most interesting of these experiments.

Experiment 12.—I burnt on a piece of wire a mixture of copper sulphate and ammonium chloride. This compound, as is well known, gives a very beautiful and complex spectrum. When the mixture is held in the inner flame it turns dark, bubbles up, and burns like a piece of pitch, giving a continuous spectrum; and upon this flame, which never passes beyond the inner flame, the reflection of the sunlight may be seen and the Frauenhofer lines distinguished. There is also, at the same time, in addition to the beautiful blue-violet coloration of the outer flame, a curious "red smoke" right on the outer edge of it. But though in a dark room this looks far more like a solid precipitate, or true smoke, than the bright flame—though by daylight it looks so "smoky" that I thought it surely must give what I sought, a reflection in the outer flame—yet the sunlight passes through it without the slightest effect, save that it renders it invisible. The spectrum of this apparent smoke consists of groups of lines in the red.[1]

Experiment 13.—I now sought a substance that should be volatile in the inner flame and give a non-volatile oxide in the outer. I placed some zinc, which I found to be the most manageable metal for this purpose, in a small iron cup in the very centre of the flame. As soon as it boiled, flashes of white light appeared in the outer flame, and I was enabled to ascertain that these flashes gave a continuous spectrum and were also capable of reflecting sunlight, the reflected light being polarised, as in the other cases, in all directions at right angles to the line of incidence.

[1] In a recent experiment this "red smoke" gave a "soft" continuous spectrum from the extreme red to the yellow a little beyond D. It is very transient, and seems to be produced when the fused mass is drawn nearly out of the flame.

I venture to think, therefore, that the proof is fairly complete that the luminosity of a candle or gas flame proceeds from incandescent matter in a state of extremely fine division, because—

(*A*) Light can be reflected from it in the same way as from very fine particles of lac, sulphur, &c.

(*B*) The reflection begins with the violet rays when the precipitate first forms, and extends to the red as it becomes denser in the upper smoky part of the flame, the spectrum undergoing a similar change to that of the acidulated hyposulphite solution.

(*C*) There is no break in the phenomena from the commencement of incandescence to the cooling smoke and even the cold soot itself. The reflection is visibly produced by any rays, whether of the sun or from a lamp, that are more intense than those of the incandescent body; and I imagine that light that is less intense is still reflected, though it cannot be discerned.

(*D*) The spectrum of light transmitted through a flame is complementary to that reflected from it, as is also the case with a solution containing fine particles.

(*E*) The peculiar property of polarising all light reflected at right angles to the line of incidence which is considered the test of solid matter in extremely fine division is possessed by all flames giving what is known as the "solid" spectrum.

(*F*) Whenever a precipitate is actually formed by a reaction known to take place in either inner or outer flame, the resulting luminous flame has the optical properties described in this paper. Thus zinc, which produces these results only in the outer flame, gives evidence of the solidity of its oxide in the form of smoke. And with the mixture of copper sulphate and ammonium chloride it is not that part of the flame that looks most like smoke to the eye, but that which gives a "hard" continuous spectrum which is found capable of reflecting light.

I am still working on the lines indicated by these experiments, and though the foregoing is all I feel justified in publishing at present, it by no means contains all the suggestive results I have obtained in my endeavour to ascertain the cause of luminosity in gases and substances vaporised in the Bunsen flame. My time is very much occupied and my appliances limited: it may be long before I can complete my researches, so I have thought it well to make public my conclusions, so far as they go.

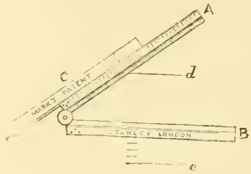
GEORGE J. BURCH

A LINE-DIVIDER

GALILEO'S proportional compasses are said to date from the year 1597. We infer that the instrument consisted of two arms, jointed, as in the accompanying figure, so that one arm could move freely about the joint. Each arm had a number of equal divisions (not necessarily of the same length on each arm), the zero point being at the joint. To divide a given length into five equal parts it is necessary to take an ordinary pair of compasses and measure the given length with these, then set the proportional compasses so that the fifth division on each arm may be at the given distance apart, then transfer with the ordinary compasses the distance between the unit divisions—this will be one-fifth of the given line. This seems to have been the manner of using the instrument employed by Galileo (cf. Marie, *Histoire des Sciences Mathématiques et Physiques*, tome iii. p. 108). Other modes of using will doubtless occur to most of our readers. The principle involved in this and similar instruments, and certainly in the one before us, is that of the proportionality of corresponding sides in similar triangles.

Our figure represents Miss Marks's patent line-divider for dividing any space into a number of equal parts. A B forms a hinged rule with a firm joint; each limb is ten inches in length (in the specimen we are describing), the limb B is bevelled, fronted with brass, and presents a straight edge, so that straight lines can be drawn along it. The limb A is also bevelled, and is divided on the bevelled edge and also on the top into eighty equal parts, so that we are enabled to divide a given length into any number of equal parts from two to eighty. A is fitted to slide in an undercut groove upon the plain rule C, which has a single line marked upon it, and is also provided with needle points on the under-side, to prevent it from slipping when placed in any position.

Suppose we take the case already considered. Slide C along A till the C line coincides with one of the lines on A, against which is the number 50. Place the corresponding line on the level of A on one end of the line to be



divided, then open out or close up the rule till the bevel of B passes through the other end of the line. Now press the points on the underside of C firmly into the paper, and slide A up till the number 4 on the line of reference is coincident with the line on C, and mark the point where the bevel of B meets the given line to be divided. Continue to move A up one division at a time till the whole line is divided. If we require lines to be drawn through the several points of division in a given constant direction, it is obvious that we must fix the instrument so that the bevel of B shall be initially in the given direction.

We have said enough to show how the divider is used, and it remains only to state that it appears to be a very handy instrument for architects, engineers, and practical drawing. Stanley, of Great Turnstile, Holborn, is the maker.

UNIVERSAL TIME AND THE RAILWAYS

ONE of the reasons why the Prime Meridian Conference met at Washington was that the United States possesses the greatest longitudinal extension of any country traversed by railway and telegraph lines, and it is quite in keeping with the spirit of American institutions that some of the most important measures necessary to carry out the resolutions of the Conference were taken by the railway men before the scientific men had begun their sittings. The action of the railway companies began as far back as 1883. It was a regular rebellion against the inconvenience of having more than half a hundred standards of railway time from east to west of the continent. At the Conference itself, Mr. W. F. Allen, one of the United States delegates, who has from the first taken the greatest interest in this special branch of the subject, brought the matter prominently before the Congress, stating what had been done. Since the Conference met, the suggestions primarily due to the railway authorities have been accepted by the Army Signal Corps and other public bodies, and from the east of Canada to the Pacific the Continent is now divided into five sections, each with its time standard, differing by one hour from those to the east and west. Thus we have Intercolonial time, Eastern time, Central time, Mountain time, and Pacific time, representing differences of one hour or 15° of longitude. We append a map, and a paper by Mr. Allen, which we have received

from an esteemed correspondent, which will show at once the history of this movement and what has come of it.

I. On November 18, 1883, the principal railway lines of the United States and Canada adopted a new method of computing and recording time, for the purpose of securing *a uniform time standard* which should simplify the business of transportation and add to the convenience of travellers. It is almost wholly for purposes of travel and transportation that the majority of people have need of accurate time, and everywhere, except in very large cities, business has always been regulated by railroad time.

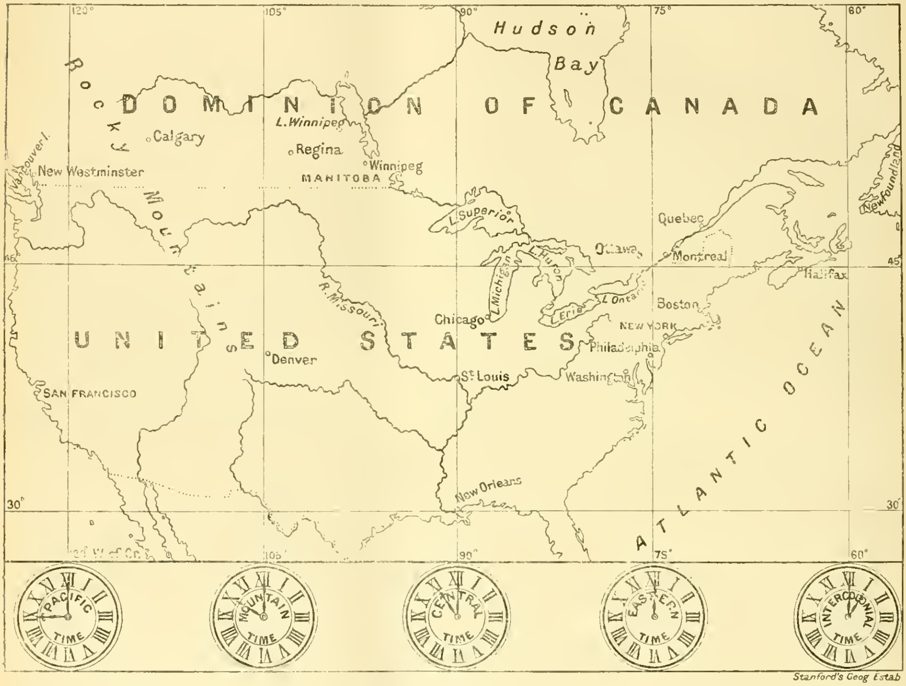
II. The defects of *the old system* of time standards were mainly as follows:—

(1) There were formerly more than fifty standards of railway time in the United States. Now there are but four.

(2) The old standards differed from each other, where they intersected, by all sorts of variations, errors, and odd minutes. Now the differences between the standards are an exact hour, and the minutes and seconds are the same in all four divisions.

(3) Formerly there were almost innumerable places at which standards changed. Now the points of change are few in number, and always at prominent points of railway departure.

(4) Formerly almost every railway centre had two or three standards of time. Chicago used three; Kansas City had five; and St. Louis, where fourteen roads centre, used six different standards.



Stanford's Geog Estab

III. In the plan which has now been adopted it was proposed:—

(1) That the same standard should govern as many railroads as possible.

(2) That the standards should not extend over so large an area of territory as to cause standard time to differ at any point by more than about thirty minutes from local time (mean solar time).

(3) That each standard should vary from the adjacent standards by the most readily-calculated difference, that of an even hour.

(4) That changes from one standard to another should be made at well-known points of departure.

(5) That these changes should be made at the termini of roads where changes naturally occur, except on the transcontinental lines, and in a few other unavoidable cases, where they should be made at the ends of divisions.

(6) That the 75th meridian west from Greenwich being almost precisely the central meridian for the system of roads using standards based upon the time of eastern cities, and the 90th meridian being equally central for the roads running by the time of western cities, the time of those meridians should be adopted for the territory which includes nearly 90 per cent. of our whole railway system. The hour meridians east and west of those named (the 60th on the east, and the 105th and 120th on the west) were found to be equally well adapted as central meridians for the roads in the section of country adjacent thereto.

IV. The problem in this country presented a feature nowhere else encountered. Standard time was introduced

throughout the island of Great Britain as long ago as the year 1848. When the railways demanded uniform time, and Greenwich time was adopted. France also has a uniform standard. But the continent of North America covers too many degrees of longitude to permit of the use of any one meridian as a single hour standard for all points between the two oceans. Under such a system there would be points where local time would differ from standard time by about two hours.

V. *The new system* divides the United States into four sections. At all places in the same section time is the same. The first section, which is governed by the time of the 75th meridian west from Greenwich, embraces all the territory between the Atlantic coast and Detroit, Pittsburg, Wheeling, Parkersburg, Huntington, Bristol, Augusta, and Charlestown, as indicated on the accompanying map (see next page). This is called *Eastern Time*. At 12.0 mid-day on the 75th meridian every clock and time-ball, from Calais to Pittsburg and from Quebec to Charlestown, indicates the hour of noon.

The second section is governed by the time of the 90th meridian, called *Central Time*. It includes all the territory from the western limits of the eastern time (that is, from Detroit, Pittsburg, Augusta, &c.) to Bismark, North Platt, Dodge City, &c. Time in this section is one hour slower than eastern time.

The third section extends from the last-named places westward to Heron (Montana), Ogden (Utah), the Needles (Arizona), &c. Time in this section is that of the 105th meridian (one hour slower than central time), and is denominated *Mountain Time*.

VI. At 12.0 noon in New York City the time at Chicago is 11 a.m., at Denver 10.0 a.m., and at Portland (Oregon) 9.0 a.m. By the old system at 12.0 noon in New York it was 11.05 in Chicago, 9.56 in Denver, and 8.46 in Portland.

VII. The adoption of a uniform standard of time by the railway lines has led to the *abandonment of local time* in nearly all the cities of the United States. The time of the 75th meridian was selected as the standard for the district of Columbia by Act of Congress, approved March 13, 1884.

It is encouraging to learn that, as was to have been expected, local time throughout the United States, as opposed to railway time, has already been abolished, and it is to be hoped, for the benefit of railway travellers on this side of the Atlantic, that the continent of Europe, from the extreme west of Spain to the Caspian, will soon be dealt with in the same manner.

NOTES

WE regret to state that Prof. Benjamin Silliman, of Yale College, died at Newhaven on the 13th inst., aged sixty-eight.

THE death is announced of Prof. Friedrich von Stein, at Prague, at the age of 67. He was appointed Professor of Zoology and Zootomy of the Prague University, an office which he occupied for thirty years.

THE death is also announced, at the age of fifty years, of Col. Roudaire, whose name is intimately associated with the project of a Saharan Inland Sea. Although strongly supported by M. de Lesseps, the scheme was opposed by the great number of competent scientific authorities. With the death of Col. Roudaire the scheme will probably fall to the ground.

THE Vice-Chancellor of Cambridge has appointed Mr. George John Romanes, M.A., F.R.S., to the office of Sir Robert Rede's lecturer for the ensuing year.

THE Royal Academy of Turin announces the foundation of a prize of the value of 12,000 francs for the most useful and striking discovery in anatomy, physiology, pathology, the exact sciences, history, geography, or statistics. The period within which the work must be done or the discovery made is from 1883 to December 31, 1886. Members of the Royal Academy or the Academy of Science in Turin are ineligible for the prize, the judges for which will be the Academy of Sciences of Turin.

THE Academy of Sciences, Berlin, announces the following subject for a prize of 2000 Marks, which, if sufficient merit be shown, will be awarded on the Leibnitz Anniversary in 1887:—"A determination of the nature of the primary assimilation-products of carbon-dioxide in plants; to be based upon suitable experiments and chemical investigations into the process in plants, when exposed to the influences of light; as well as upon direct histological demonstrations of the form it assumes in the tissues of the plant. The first form assumed by the assimilation-product is to be distinguished from the succeeding ones which the substance passes through in the metabolism of the cell. The chemical formulæ are also to be given. It will be considered an approximation to the solution of the question, if, by going over the work that has been done already on this subject, it shall be shown by an accurate series of observations and experiments that the present theories concerning the process of assimilation in plants and the primary organic product of this process, are susceptible of a wider extension, or that they require to be limited by important qualifications." Essays may be written in German, Latin, French, English, or Italian, and must be forwarded before January 1, 1887.

FROM subsequent information with regard to the accident to Dr. Divers, Principal of the Imperial College of Engineering, Tokio, it appears that he had taken in his hand a bottle supposed to contain perchloride of phosphorus, but, finding the stopper fast, was heating the neck to release it, when it burst, the bottle disappearing as dust, and the contents as gas. Dr. Divers was nearly suffocated by the fumes, and one eye was injured. When the last mail left, it was not in a state to be critically examined; but strong hopes are entertained that the sight will be restored. The accident is supposed to be due to the decomposition of the perchloride of phosphorus, which was old. Dr. Divers was at work on a paper on the theory of acids when the accident occurred.

THE undertaking to transport a whole Japanese village, with its shops, houses, and inhabitants, half round the globe to London, was a somewhat bold one for a private individual. But it has been performed with great thoroughness and success in the case of the Japanese village now on view at Knightsbridge. The houses are new and clean, which the tenements of Japanese villages always are not; the small temple or shrine is rather more cleanly and ornamental than is usual with these structures in real life; the wrestlers do not exhibit the physical characteristics which are so conspicuous, not to say disgusting, in the real Japanese wrestler; and their methods of refreshing themselves between the bouts are more in accordance with European tastes. But, on the whole, home-loving English people have now an opportunity of seeing the Japanese at home, which they can never have without a journey to Japan itself. There is very little to note in the exhibition from a scientific point of view; the inhabitants are fair average specimens of Japanese artisans and shopkeepers, so that the ethnologist will have a good opportunity of comparing his notions gathered from Miss Bird and other writers of the Japanese people with the reality. He can, in a measure, study the racial characteristics of the Japanese *in situ*.

THE Spanish earthquakes have continued to manifest themselves at intervals during the past week in the same area as that in which they first appeared. In connection with this phenomenon, the following extract from the report of the meeting of

the Spanish Natural History Society of January 7, 1885, has been forwarded to us from Madrid for publication:—Mr. Joseph Macpherson made the following remarks on the earthquakes in Andalusia:—"The earthquake which took place in the peninsula on the night of December 25 last, and which cannot yet be said to have ceased, has assumed a character of such intensity, and presents in its action such marked coincidences with the geological structure of this part of the world, that I think it will be interesting to enter into some detail with regard to the principal conclusions to be deduced from that phenomenon. Taking the whole peninsula, the disturbance may be divided off into three successive phases, viz.: one of relatively slight importance which occurred in the early morning of December 22, and which was confined to the western portion of the country, its effects being felt only in Galicia and Portugal; another, of the highest importance, which occurred three days later, namely, at 9 p.m. on the 25th of that month; while the third phase includes the oscillations which have taken place, and are still taking place, in the districts most severely affected by the earthquake of the 25th. That earthquake extended over a very considerable surface, the district affected to an appreciable degree including approximately, it would seem, the whole country lying between Cadis and Cape de Gata and between Malaga and the Carpathian range. According to all the data known to us so far, the oscillations gained in intensity as they proceeded southwards from those mountain ranges, reaching their maximum of motion in the region lying between the mountains of Ronda and the Sierra Nevada. The shock was quite perceptible at Madrid, where it was strong enough to stop a few clocks and ring a few bells. The movement was apparently that of a pendulum, and its direction was from north to south. Two successive oscillations were observed separated by an interval of from three to four seconds, and each oscillation lasted from two to three seconds. The movement gained in intensity, as I have said, as it proceeded southwards, more especially after leaving the southern border of the central tableland limited by the fault of the valley of the Guadalquivir. Now, the interest of the phenomenon lies in the coincidence observable between its various manifestations and the geological structure of the peninsula. To make this clear, let me be permitted to offer a few observations on the subject of that geological structure. The archaic formations of the peninsula, with rare exceptions, lie in folds and faults running with singular consistency from south-west to north-east, and as an instance of this peculiarity I may mention the Carpathian range, which crosses the peninsula from east to west. After these archaic disturbances the Cambrian and Silurian deposits were likewise in their turn crumpled up into folds. These, however, run from north-west to south-east, that is to say, in a direction which forms almost a right angle to the earlier archaic folds. Concurrently with this general crumpling of the lower Palæozoic strata, there appeared in a broad zone great masses of granite, porphyry, diabase, and other kinds of rocks, which cross the peninsula from Galicia to the valley of the Guadalquivir, and which, geologically speaking, divides the peninsula into two distinct parts. This huge belt, which may be regarded as one of the most striking features of the peninsula of our day, cuts and divides the archaic formations, as this may be perceived at once in the central Carpathian range itself, which is interrupted between the Sierra de Gata and the Estrella range in Portugal. A study of the Mediterranean watershed of Andalusia will show the existence of two great mountain masses, chiefly formed of archaic deposits. One of these is known by the name of the Serrania de Ronda, and the other by that of the Sierra Nevada. Both run in a series of folds and faults from south-west to north-east, and between them there lies an interval filled up with palæozoic, secondary, and tertiary deposits. Towards the middle of this interval there rises up, like an island in the midst of these later deposits, a series of ridges running from north-west to south-east, and formed of archaic rocks. They are known by the name of the Sierra Tejea and Sierra Almijara, and the folds of these ranges, as in the case of the other archaic formations, run from south-west to north-east. It is clear, therefore, that this intermediary mountain mass is a segment of a more considerable archaic formation, separated from adjacent rocks through the subsidence of the ground on both sides. Owing to constant oscillations, this detached portion has been covered with the thick mantle of sediment which now overlays it, and its structure is easily accounted for as the result of that great fracture which crosses the peninsula from north-west to south-east, in the prolongation of which lies the region I am now describing. This fracture does not evidently end in the valley of the Guadalquivir, and though the surface be covered over by later deposits, it apparently extends to the country lying between the archaic mountain masses of the Serrania de Ronda and the Sierra Nevada, which it divides from one another, and whose ancient unity is testified by the Sierras Tejea and Almijara. The two principal coincidences observable between the phenomena of the earthquake and the geological structure of the peninsula are:—(1) That the disturbance of December 22 was confined to the regions lying to the west of the zone above described; and (2) that the most violent shocks of the earthquake of December 25 were experienced in the region intervening between the Sierra Nevada and the Serrania de Ronda, and precisely on the very belt which incloses the archaic mountain mass of the Sierras Tejea and Almijara. That part of Andalusia, broken and torn by the secular disturbances of our globe, has proved naturally the weakest, and has, therefore, been the most exposed to the shocks from which Andalusia has so terribly suffered. There stood Alhama, now prostrate in the river bed; there, Periana, a heap of ruins 3 m. high; there Albuñuelas, which exists no longer; there Zafarraya, Nerja, Torrox, and many other towns and villages; all testifying to the fragility of those faults, which though dating back to the Silurian period, are still apparently not completely welded.

Mr. G. Johnstone Stoney, F.R.S., Vice-President of the Royal Dublin Society, will give a discourse at the Royal Institution on Friday evening, February 6, on "How Thought presents itself in the Phenomena of Nature"; and on the following day (Saturday) he is to begin a course of three lectures upon the "Scale on which Nature works and the Character of some of her Operations." The following are the titles of the three lectures:—"Operations of Nature carried out on a Great Scale"; "Operations which go on between Molecules"; and "Operations which go on within Molecules, and the more Subtile Operations of Nature."

According to *Science*, about 10 per cent. of the plants collected in the North-Western Mexican States by recent collectors prove to be new species.

May we suggest to the authorities of the British Museum the desirability of taking some means of letting the public interested in the matter know some little time beforehand when those lectures are to be delivered which are so regularly reported in the *Times*, but of the arrangements for which no one seems to know anything?

Dr. J. A. Fleming is about to give, at University College, Gower Street, a course of lectures on "Modern Applications of Electricity in the Arts." The lectures will be interspersed with practical demonstrations.

The Electrical Exhibition, which was to take place at the Paris Observatory in the beginning of January, has been postponed to March 19.

THE thirty-eighth annual general meeting of the Institution of Mechanical Engineers will be on January 29 and 30, at 25, Great George Street, Westminster, by the kind permission of the Council of the Institution of Civil Engineers. The chair will be taken by the President at half past seven p.m. on each evening. The following reports and papers will be read and discussed, as far as time will admit:—Final report on experiments bearing upon the question of the condition in which carbon exists in steel, by Sir Frederick Abel, C.B., D.C.L., F.R.S.; second report of the research committee on friction; on recent improvements in wood-cutting machinery, by Mr. George Richards, of Manchester; on the history of paddle-wheel steam navigation, by Mr. Henry Sandham, of London; description of the Tower spherical engine, by Mr. R. Hammersley Heenan, of Manchester.

THE Dutch Government have issued the first part of their official report on the Krakatoa eruption. It deals with the history of the island prior to the occurrence, and the events of the catastrophe itself. The second part will deal with the scientific results of the investigation. The editor examined 1300 reports of eye-witnesses, and has endeavoured from them to construct a chronological statement of the events preceding and accompanying the eruption.

THE list of the conferences of the Sorbonne has been published for this year. On January 24 Dr. Brouardel lectures on the epidemics and protective measures; February 7, classification of celestial bodies according to their nature, by M. Faye; February 21, application of recent advances in physics to public works, by M. Gariel; March 14, architecture of the heavens, by M. Wolf; April 9, great volcanic catastrophes, by M. Velain.

WE are requested to state that Dr. William Pole, F.R.S., has been appointed Honorary Secretary of the Institution of Civil Engineers in the room of the late Mr. Charles Manby. The office of Secretary is filled, as formerly, by Mr. James Forrest. Mr. H. L. Antrobus has been re-appointed Treasurer.

MOST of the inhabitants of Leden, the *Standard* states, about a mile from Colchester, were awakened shortly after midnight on Sunday by what they believe to have been an earthquake. Much alarm was occasioned. The shock occurred at half-past twelve o'clock, and lasted about thirty seconds. The houses shook and the crockery rattled, but the shock was nothing like so severe as the one experienced last April. The shock seems to have extended as far north and east as Aldeburgh.

SEISMIC activity appears to have been exceedingly widespread recently. In the middle of November the first earthquake in ten years occurred at Monkden, in Manchuria. Both shocks, the present and one ten years ago, came from the same direction, viz. north-west to south-east, which, it is curious to note, is not the prevailing direction of the hill ranges, but at right angles to it. The Chinese in Manchuria are persuaded that warning of approaching earthquakes is given by the Coreans to the Chinese Government, and that the shaking of the earth is caused by the yawning of the great fish, on which the globe reposes.

IT is reported from Sundal and Oxendal, on the west coast of Norway, that a severe shock of earthquake was felt there at about 7 a.m. on December 28. The shock was so violent that the houses shook, and the people ran out terrified. It was impossible to tell in what direction the shock went. This phenomenon is remarkable for two reasons, viz. that it hardly ever occurs in Norway, and that it occurred on the day after the terrible earthquakes in Spain.

THE prospectus has been issued of the *American Journal of Archæology*. The Archæological Institute of America has recognised the *Journal* as its official organ. Among the specific objects of its editors will be:—(1) To afford to American scholars the means of taking active part in the progress of archæological science by the publication of papers embodying the results of original research; (2) To provide a careful and ample record of archæological discoveries and investigations in all parts of the world, and to furnish reports of the proceedings of archæological societies, summaries of important papers, reviews of books, &c.; (3) To bring to notice and to illustrate important works in the domain of archæology contained in our public museums and private collections, now little known. The following is a list of the editorial staff, so far as at present formed:—Advising Editor: Prof. Charles Eliot Norton, of Harvard College; Managing Editor: Dr. A. L. Frothingham, of Johns Hopkins University; Special Editors: Dr. A. Emerson, of Johns Hopkins University, Mr. T. W. Ludlow, of New York, Prof. Allan Marquand, of Princeton College, Mr. A. R. Marsh, of Harvard College, Mr. Charles C. Perkins, of Boston. The *Journal* will be published four times a year, and the numbers for each year will form an 8vo volume of about 360 pages. Messrs. Trubner and Co. will be the English agents.

AT Königsberg, in Prussia, will take place during the months of May to August of this year an International Industrial and Polytechnic Exhibition for machinery, motors, tools, appliances for mechanics, small manufacturers, &c. The following are some of the heads of groups under which exhibits will be classified—viz. (1) motors; (2) transmission appliances; (3) tools and implements for all branches of manufacture; (4) chemical and physical apparatus; (5) apparatus for technical education; (6) safety and protective appliances; (7) machinery and appliances for household purposes and for innkeepers; (8) agricultural implements and appliances. The Exhibition takes place under the authority of the Industrial Central Union of the province of East Prussia. Dr. N. Heinemann, of the new Athenæum Club, 3, Pall Mall East, has been appointed Special Commissioner of the Exhibition for England, and will give all necessary information to intending exhibitors.

THE annual meeting of the Association of Assistant Mistresses, which is confined to mistresses in girls' high schools, endowed, and proprietary schools, was held on Saturday at the North London Collegiate School for Girls. The President, Mrs. Hankin, of the Edgbaston High School, Birmingham, was in the chair. The discussion of the rules of the Association occupied a large proportion of the time. The Secretary's report showed that the work of the past year (the first of the Association's existence) had been chiefly that of organisation, whilst the Treasurer's report gave a hopeful account of the finances of the institution, there being a considerable balance in hand. It was resolved to appoint foreign and colonial correspondents, whose duty it should be to inform the Association of openings abroad, and a home correspondent, to whom assistant mistresses might apply, and to whom notices of vacancies might be sent. A plan for a lending library, to consist chiefly of voluntary loans of books, was approved, and a sub-committee was appointed to carry it into effect. A hope was expressed that publishers might be induced to present copies of educational works, and that any friends to the Association, leaving England for a time, might grant the use of their books during their absence. Mrs. Bryant, D.Sc., was elected President for the coming year. After the conclusion of business, the meeting proceeded to the discussion of papers on educational subjects. Miss Sharpe of Bradford read a paper on the training of teachers. Several papers were also read on the correction of exercises, describing the systems obtaining at different schools. It is from the discussion of such papers that the Association anticipates practical results: by their means, ideas are circulated that would otherwise remain unknown to the majority, and hints given by which all interested in their

work will profit. Papers on educational subjects will be read at the spring meeting, which is to take place in the middle of April at the Girls' Grammar School, Bradford.

OLD residents of the California peninsula have noticed several varieties of birds near the sea coast that they have never before known to leave the mountains. This is supposed to indicate a severe winter, but the migration is more probably due to the prevailing scarcity of all kinds of seeds in the mountains this season.

ACCORDING to the report of the captain of a vessel which in December returned from Eskefjord, on the east coast of Iceland, showers of ashes fell on Eastland early in November. The deck of the ship was covered with a thin layer of ashes, probably caused by a volcanic eruption inland.

MR. W. HEWITT, Science Demonstrator to the Liverpool School Board, writes to us with reference to the "Itinerant" method of science teaching. The special instruction is, in Liverpool, he states, commenced with the children in the *fourth* standard, and by this means deals with more than double the number of children who would be included were the commencement deferred until the fifth standard, as appears to be the case in Birmingham. There is every reason to believe, Mr. Hewitt thinks, that the preliminary instruction in the fourth standard is a very important part of the intellectual training which it is the object of the system as a whole to give. The stages of instruction in each subject are kept quite distinct throughout, and are always taken in the same order. The children on commencing the subject take up the first stage, and proceed in the following year to the second stage, and so on through a systematic and carefully-graduated three (or four) years' course of instruction in elementary science.

THE hatching of lobster and fish is making great progress in Norway. Thus, last year the Association for the Promotion of the Norwegian Fisheries hatched 7,000,000 fish, chiefly cod and haddock, at their establishment of Arendal, in the Christiania fjord, and this winter between 50,000,000 and 60,000,000 more will probably be turned out. The experiments, which were made of placing the ova of lobster in hatching apparatus, have been attended with great success, and show that they may be turned out by the million in this manner. As private enterprise cannot be expected to undertake these operations from year to year on a large scale all along the coast, the Association have petitioned for Government support, which will, it is expected, be readily forthcoming, as the Norwegians now clearly see of what enormous benefit to the nation these operations are.

MR. NEWALL asks us to state that in his note on "The *Jeannette* Drift" (vol. xxxi. p. 102), the word *knots* should be *nauts*, a *naut* being a geographical mile of 60 to a degree. It is a much more convenient measure than the mile of 1760 yards, for it contains 1000 fathoms, or ten cables of 100 fathoms each, as used in the navy. It is the only decimal measure used in any Government department! *Knot* is a mark on a line used on board ship, having the same proportion to a *naut* which a half-minute glass has to an hour, or the 1/120th part of a naut; so, when 10 knots pass out during one turn of the glass, the sailor means that the vessel is passing through the water at 10 nauts an hour.

THE additions to the Zoological Society's Gardens during the past week include a Golden Eagle (*Aquila chrysaetos*) from Sutherlandshire, presented by Col. E. D. Hunt; a Crossbill (*Loxia curvirostris*), British, presented by Mr. G. Skegg; seven Bramblings (*Fringilla montifringilla*), two Chaffinches (*Fringilla cœlebs*), a Tree Sparrow (*Passer montana*), a Black-headed Bunting (*Emberiza melanocephala*) from Norfolk, presented by Mr. T. E. Gunn; a Nilotic Crocodile (*Crocodilus vulgaris*) from Africa, presented by Mr. H. E. Cree; a Brush-tailed Kangaroo (*Petrogale penicillata* ♂) from New South Wales, a Golden-crowned Conure (*Conurus aureus*) from South-East Brazil, deposited; two Striated Tanagers (*Tanagra striata*) from Buenos Ayres, two Siskins (*Chrysomitris spinus*), British, purchased; a Virginian Fox (*Urocyon virginianus*) from North America, received in exchange.

OUR ASTRONOMICAL COLUMN

COMETS OF SHORT PERIOD. (1) ENCKE'S COMET.—The following ephemeris of this comet for February is founded upon Dr. Backlund's elements, which the January observations show to be very exact:—

At 6h. Greenwich Mean Time

1885	R.A. h.	m.	s.	Decl. °	′	Log. distance from Earth	Sun
Feb. 1	23	33	0	+6	32·4		
2	—	34	31	6	38·6	0·0884	9·9279
3	—	36	3	6	44·7		
4	—	37	35	6	50·7		
5	—	39	8	6	56·4		
6	—	40	40	7	2·1	0·0705	9·8901
7	—	42	13	7	7·5		
8	—	43	45	7	12·7		
9	—	45	17	7	17·5		
10	—	46	49	7	21·9	0·0490	9·8478
11	—	48	20	7	25·8		
12	—	49	50	7	29·2		
13	—	51	18	7	31·9		
14	—	52	44	7	33·9	0·0233	9·8003
15	—	54	7	7	34·9		
16	—	55	26	7	34·9		
17	—	56	41	7	33·7		
18	—	57	52	7	31·1	9·9924	9·7470
19	—	58	57	7	26·9		
20	23	59	54	7	20·7		
21	0	0	42	7	12·4		
22	—	1	20	7	1·4	9·9555	9·6881
23	—	1	46	6	47·5		
24	—	1	57	6	30·1		
25	—	1	51	6	8·9		
26	—	1	25	5	43·2	9·9123	9·6263
27	0	0	36	5	12·4		
28	23	59	22	+4	35·9		

(2) BARNARD'S COMET.—Dr. Berberich, of Berlin, has made a new determination of the orbit of this comet from three normal positions deduced from observations extending over a period of three months. The sidereal revolution is now found to occupy 1958·9 days, or 5·363 years. In heliocentric longitude 343° 40′, the distance of the comet from the orbit of Mars is only 0·0079, and a revolution but slightly differing from that obtained by Dr. Berberich would have caused a very close approach of the two bodies as lately as the end of 1873 or beginning of 1874. The distance of the comet at aphelion from the orbit of Jupiter is 0·572. As previously remarked, much interest attaches to this comet from the similarity of the elements of its orbit to those of "the lost comet of De Vico," observed in the autumn of 1844.

(3) WOLF'S COMET.—Dr. Tempel, writing from Arcetri on the 4th inst., describes this comet as being still "sehr hell mit leicht zu beobachtendem Kerne." Considering that accurate observation commenced on September 20, the mean motion may be expected to be pretty exactly defined by the observations at this appearance, and the comet's orbit previous to the near approach to the planet Jupiter in 1875 may be investigated, with probability of a reliable result, without waiting for observations at its next return to perihelion in 1891.

GEOGRAPHICAL NOTES

THE *Bulletin de la Société de Géographie* for the last quarter of 1884 is largely occupied with the geography of the Far East. Two members of the foreign mission body communicate papers on Tonquin, both accompanied by maps. Père Pinabel writes on some "savage peoples" dependent on Tonquin. The expression "savage" is explained to mean nothing more than mountaineers. The tribes here described inhabit the mountains of the province of Thague-hoa, between the rivers Maa and Chou, which is the most southern province of the delta of the Red

River, and not far from the Annamite border. The tribes called Phon-tays, live in a sort of semi-independence, like the Laos tribes, in the mountains on the Siamese frontiers. A third tribe inhabiting the region is called by Père Pinabel the Méos (Mois?), and are said by him to be in all probability the aboriginal Miao-tsze of South-Western China, although whether he has any ground for this belief beyond the resemblance of the names does not appear. At any rate, it is evident from their customs and language that they are Chinese. A fourth tribe is called the Sas, of whom nothing appears to be known except that it fled to the borders of Annam during one of the numerous wars of that region. A long and tolerably detailed account of the manners and customs of the Phon-tays is given, and shorter ones of those of the Mois and Sas. They are all the more interesting that the writer appears to have no idea of ethnology, and therefore is not on the look-out for parallels elsewhere, but records everything with simplicity and directness. Père Blanck's experiences lay also in the Laos States, on the frontiers of Siam and Tonquin, but to the south of those of his colleague. His paper is simply a record of his journeys among the "savages" in the mountains between the province of Nghé-Ane, the most southern province of Tonquin bordering on Annam, and the Mei Kong River. Both these papers are taken from the reports of the *missions étrangères*. M. du Cailland describes the Quang-si, or Kwang-si, the province of China adjoining Tonquin, and that from which the greater part of the Chinese invading force is drawn. The writer discusses the routes from Langson into China, the river-system of Kwang-si, its administrative divisions, its ethnography, recent history, and the Catholic propaganda there. According to M. du Cailland, the Chinese population there is nothing more than a colony of Cantonese amongst the vast numbers of Miao-tsze and Laos in the western portion. Unfortunately, the writer has omitted his authorities for this statement, although his references in other portions of the paper are somewhat copious. It would be of great interest to learn on what grounds the wealthiest and most populous province but one of Southern China is believed to be only a Cantonese colony, while the Miao-tsze, who are generally believed to exist only in small and weak communities scattered over the central part of South-Western China, are masters of this vast district. The geography and ethnography of China must be rewritten, if M. du Cailland is accurate in this portion of his paper.—M. Huber continues his account of his journey in Central Arabia, which has been already noticed.—Prince Roland Bonaparte describes fourteen voyages to the coasts of New Guinea, made by Dutch Government vessels, between 1876 and 1883. They went chiefly from Ternate. Each voyage is described in detail, apparently from official sources. The conclusion of the paper is that it is easy to see from this account that the Dutch have annexed in a definite manner the eastern part of New Guinea to their empire in the Malay Archipelago.—M. Simonin discusses the progress of the Australian colonies commercially and politically.

AT the last meeting of the Gesellschaft für Erdkunde in Berlin (January 3) Dr. Steinmann read a paper on his journeys in Southern Patagonia. In 1882 he went as geological assistant to the fourth German expedition to Punta Arenas, mainly with the object of studying the Southern Cordilleras. What struck him particularly here was the extraordinary difference in the plant forms to those on the Southern Cordilleras, while on the western slopes vegetation is rich in forms, the climate of the steppes reigns on the eastern side. From a geological point of view, the southern point of America is extremely simple in its build, but it is of a different character on the east and west. On the east chalk formations occur almost entirely, while on the west, where there are innumerable islands, there is nothing but granite and crystalline rocks. Although the configuration of the coast has been studied thoroughly by the English, Dr. Steinmann thinks that many important questions have still to be settled; for instance, whether Laguna Blanca, lying to the north-east of the settlement Kyrsing Water, has an outlet to the west. Ultimately the lecturer reached the Laguna of the third settlement of Santa Cruz, of which it may with certainty be said that was connected until recently with the Pacific Ocean. It may also be concluded that at that time the mainland was much more cut up by channels and waterways than it is now. In May 1883 Dr. Steinmann visited, in the company of Fuegian seal-hunters, the islands south of the Straits of Magellan, including Tierra del Fuego. Ultimately, he made his way from the southern point of America to Bolivia, and here continued his investigations.

THE Society of Naturalists in St. Petersburg has received permission to despatch several of its members to join the Russian representatives on the Afghan Boundary Commission, with the view to the scientific exploration of Central Asia. The English Commission, which is now on the spot, has, it will be remembered, a geologist, a naturalist, and topographers amongst its number.

THE *Daily Telegraph* is publishing a series of articles descriptive of the Kilimanjaro expedition, "by its leader," Mr. H. H. Johnston. They are full of interesting detail.

WITH the commencement of the new year *L'Exploration* has taken a new form and a new title. It is now called *La Gazette géographique et l'Exploration*, and is about double its former size, the pages being larger and arranged in double columns. We trust that with this improvement there may be a corresponding advance in its usefulness as a geographical journal.

Petermann for January contains an article and map on the journey of the pundit A—— R—— in Eastern Thibet during the years 1878–82. Dr. Richard Lüddecke writes on the Italian emigration of 1883 from official sources. France takes nearly half of the emigration to European countries, while the State of La Plata and North America take the largest share of the extra-European emigration. Dr. Pauli writes on the Cameroons, and Herr Regel describes a journey from Charjui by Merv to Pandy, and back to Samarkand.

GEOLOGY OF AFGHANISTAN

THE *Times*, in the letter from its correspondent with the Afghan Boundary Commission, publishes the following notes supplied by Mr. Griesbach, of the Indian Geological Survey:—

"The hill ranges between Kushkak and Pahri in the Herat valley are all apparently composed of rocks belonging to the Cretaceous and younger periods. So far as I could judge, the ranges are formed by a series of parallel anticlinal folds of the Upper Cretaceous rocks, which in this part of Afghanistan (as in a great part of Persia) are hippuritic beds. They are mostly limestones, dark gray to white, and contain fossils in abundance, among which several species of hippurites are the commonest. The igneous rocks which play such an important part within the hippurite area in the Candahar district were also met with here under exactly the same conditions. Basic rocks (trap) are intimately connected with the Cretaceous limestones in this area also, and it would be impossible to distinguish them on anything but a very detailed geological map. Here also the limestone near the contact with the trap (and other igneous rocks) has been converted into a white, fine-grained marble, much used by the natives of Southern Afghanistan for monumental purposes. But by far the most interesting of the igneous rocks is a syenitic granite which appears in several patches. The Karez-i-Dasht is composed entirely of this rock, which is seen to be capped by trap in the surrounding hill ranges. Its age is most probably younger than that of the trap through which it has burst. This group of rocks, with the exception of patches of younger Tertiary rocks, form all the ranges up to and including part of the Chillingak range and pass (near Pahri). The latter range, in which the conspicuous Doshakh peaks are situated, is of great geological interest. It is an anticlinal fold, the centre and northern axis of which is formed by Palæozoic rocks; so far, I have only been able to detect Carboniferous fossils in a series of dark blue limestone beds, but it is quite possible that older groups are also there. The ravine leading to the high points south of Robat-i-Pai Ziarat has excavated its course through Carboniferous beds only. The beds dip north and below the younger gravels and fan deposits of the Heri Rud. But on the right bank of the valley, rocks appear again of an entirely different look, and it is quite possible that members of the lower Mesozoic system are represented there. The southern flank of the Chillingak range is formed only by Cretaceous beds—sandstones and shales of the Kojak type, overlaid with hippuritic limestone near Pahri. The connection of these beds with the Palæozoic strata of the centre is quite hidden. The older river deposits and Dasht beds are clays, sandstone, and conglomerates much of the same character as already described from the Helmund. They form thick deposits south of Pahri and in the Heri Rud Valley, and I have found remains of mammalian bones in them.

I believe them to belong to the upper beds of the Siwalik series. In connection with the notes which I was enabled to make during the very hasty examination of the ground travelled over, two facts seem to me to be of considerable importance. The first is the reappearance of older strata than Cretaceous, and strata of distinctly a Himalayan type. One of the great problems of Asiatic stratigraphy is the exact connection of the sedimentary rocks of the North-West Himalayas with the system of the Caucasus, which is again only a continuation of the Alpine system; whether or not the Hindoo Koosh may be looked upon as a continuation of our North-West Himalayas can only be decided after an examination of its geotectonic features. The connecting link, so to speak, has yet to be found. But the finding of true Carboniferous marine beds containing *Productus semireticulatus* in a range which belongs to the Hindoo Koosh system is a distinct step towards the solving of the great stratigraphical problem of Central Asia. The second fact is of rather an economic than purely scientific interest. I found at more than one place along the route an altered rock near the contact of the hippuritic limestone and the igneous rocks, which in character resembles exactly the gangue in which at Candahar the gold and other minerals occur. So I believe that a careful search would certainly reveal similar ore-deposits in the Sabzawar and Herat districts. I may here mention again that the contact rocks in the Candahar district contain exactly the same minerals as do the altered hippuritic limestone beds of the Banat in Hungary, which also have been disturbed by young granitic rocks."

The same Correspondent, in a previous letter, describes the journey across Seistan from Khwaja Ali to Lash Jowan. The geological features of this part of Seistan are, according to Mr. Griesbach, extremely simple. Only post-tertiary and recent deposits were met with; the former are fluviatile beds, mostly clays, soft sandstones, and gravels, in character much the same as those forming the tableland of Handesin Tibet, and probably belonging to the same age. The drainage of the area during post-tertiary times seems to have been generally identical with the present one, though, perhaps, of a more extended nature. The recent gravel beds and conglomerates containing worn material from the neighbouring hill ranges are found in the Farah Rud and the Kash Rudak in considerable thickness, capping the underlying clays and sandstones of post-tertiary age. Locally, the conglomerate is replaced by a hard limestone breccia, as for instance at Galichah and also the Helmund. But the general character of this deposit is that of the Indus valley gravels, which are seen to overlie unconformably the younger Siwaliks along the Marri and Bugti hills and the Suliman range. They are found of course within the area of the present drainage. Of useful minerals, only gypsum exists, which is found in the post-tertiary clays, fills fissures and joints, and may perhaps also be found in larger masses. Apparently it is made use of for the manufacture of Gutch or plaster; traces of diggings for it are found near Lash.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The following scheme of lectures and classes in Natural Science has been issued by the Faculty for Lent Term, 1885:—

In the Physical Department of the Museum Prof. Clifton continues his course on the Galvanometer and Ohm's Law. Practical instruction in Physics is given by the Professor and by Messrs. Walker and Selby. Mr. Walker lectures on the Theory of Errors, and Mr. Selby, on Elementary Mechanics. At Christchurch Mr. Baynes lectures on Electrodynamics, and has a class for practical instruction in Electrical Measurements. At Balliol Mr. Dixon lectures on Elementary Magnetism and Electricity.

In the Chemical Department of the Museum Dr. Odling continues his course on the Adipic Compounds. Mr. Fisher lectures on Inorganic, and Dr. Watts on Organic, Chemistry. At Christchurch Mr. Harcourt lectures on the Non-Metallic Elements, and at University Mr. Veley lectures on Physical Chemistry.

In the Morphological Department of the Museum Prof. Moseley continues his course on the Comparative Anatomy of the Invertebrata. After each lecture special instruction is given in illustration of the lecture. Dr. Hickson lectures on Animal Morphology, Mr. Barclay-Thompson on the Anatomy of Mammalia, Mr. Hatchett Jackson on the Principles of Comparative Embryology and Development, and Mr. Poulton on the Distribution of Animals.

In the Physiological Department of the Museum Prof. Burdon-Sanderson lectures on the Nervous System, and practical instruction is given by the Professor and Messrs. Dixey and Gotch.

In the Botanic Garden Prof. Bayley Balfour lectures on Elementary Morphology and Physiology, and on the Morphology of the Vascular Cryptogams. Prof. Gilbert lectures on the Result of Field Experiments.

Dr. Tylor lectures on the Early History of Arts and Sciences; Prof. Maskelyne on the Rectangular-axed Crystal Systems; Prof. Prestwich on the Palæozoic and Mesozoic Series.

It is rumoured that the grant to carry on the new physiological laboratory under Prof. Burdon-Sanderson will be opposed in Convocation by the anti-vivisectionists. If this should turn out to be true, it behoves all members of Convocation who side with the advancement of science to come up and record their votes.

CAMBRIDGE.—The Board for Physics and Chemistry announces the following lectures for this term:—

Chemistry: Prof. Liveing, General Course; Prof. Dewar, Organic Chemistry; Mr. Main, St. John's, General Course; Mr. Pattison Muir, Caius, General Principles, advanced, especially Physical Chemistry; and Elementary Course for 1st M.B.; Mr. Scott (Prof. Dewar's assistant) Elementary Organic Chemistry; Mr. Heycock, King's, Chemical Philosophy for Tripos, Part I.; Practical Chemistry, Mr. Sell and Mr. Fenton, three courses of demonstrations, for medical students, Tripos Part I. and Tripos Part II.; Mr. Robinson, Chemistry as applied to Agriculture; Sidney College Laboratory, Demonstrations for 1st M.B., with explanatory lectures.

Physics: Prof. Stokes, Hydrodynamics; Prof. Thomson, Magnetism; Mr. Atkinson, Trinity Hall, Heat and Hydrostatics; Mr. Glazebrook and Mr. Shaw, Elementary and Advanced Physics; Mr. Hart, St. John's, Light and Electricity, elementary and advanced; Practical Physics, Demonstrations in Cavendish Laboratory, three courses.

Mineralogy: Prof. Lewis, Lectures and Demonstrations.

Mechanism: Prof. Stuart, Mechanism and Applied Mechanics, and Theory of Structures; Mr. Lyon, Elementary Mathematics, and Statics and Dynamics.

The Board for Biology and Geology publish the following list of lectures:—

Geology: Prof. Hughes, Pleistocene, with special reference to Prehistoric Archæology; Dr. R. D. Roberts, Physiography, and Class Work; Mr. Marr, Geological Evolution; Mr. T. Roberts, Palæontology; Mr. Teall, Advanced Petrology; Mr. Harker, Elementary Petrology and Class Work; Prof. Hughes, Field Lectures.

Botany: Dr. Vines, General Elementary Course, with practical work; Mr. Gardiner, Anatomy of Plants, advanced, with practical work; Dr. F. Darwin, General Biology of Plants; Mr. J. W. Hicks Sidney, Elementary Course; Mr. Potter, Classification of Gymnosperms and Monocotyledons.

Elementary Biology: Dr. Vines and Mr. Sedgwick.

Zoology: Prof. Newton, Geographical Distribution of Vertebrata; Mr. Weldon, Practical Morphology, Invertebrata; Mr. Sedgwick, Anatomy and Embryology of Vertebrata, elementary; Mr. Harmer, Osteology of Vertebrata, and advanced course on Arthropoda, Mr. Gadon, Palæontology and Affinities of Groups of Mammalia.

Physiology: Prof. Foster, Elementary Course; Mr. Lea, Chemical Physiology; Mr. Langley, Advanced Course; Dr. Gaskell, Circulation and Respiration, advanced; Mr. Hill, Class for 2nd M.B.

Human Anatomy: Prof. Macalister, Organs of Circulation and Respiration; Demonstrations in Osteology.

The Board for Mathematics announces the following lectures on higher mathematics this term:—Prof. Stokes, Hydrodynamics; Prof. Adams, Lunar Theory; Prof. Thomson, Trinity College, Electromagnetism; Mr. Hobson, Christ's, Planetary Theory; Mr. Glazebrook, Theory of Light; Mr. Forsyth, Functions of Complex Variables; Dr. Pesant, Analysis, Definite Integrals, Calculus of Variations and Differential Equations; Mr. Mollison, Fourier's Series and Conduction of Heat; Mr. Pendlebury, Analytical Optics; Dr. Routh, Attractions and the Figure of the Earth; Mr. Stearn, Electrostatics.

Mr. G. J. Romanes, LL.D., F.R.S., has been appointed to deliver the Rede Lecture this year.

R. E. Fry, Clifton College, has been elected to a Natural Science Open Exhibition at King's; W. J. Elliott, Newcastle

School, Staffs., and A. E. Potter, Yorkshire College of Science, to Entrance Scholarships at Christ's College; H. Bury, third year, and F. W. Oliver, second year, to Foundation Scholarships at Trinity College.

S. F. Dufton, Grammar School, Bradford, has been elected to an Open Exhibition for Natural Science at Trinity College, and A. E. Mayeur, St. Paul's, to an additional Exhibition.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, 708, December, 1884.—G. Forbes, dynamo-electric machinery; a full report of the lecture given by Prof. Forbes at the Philadelphia Exhibition.—R. H. Thurston, steam boilers as magazines of explosive energy. This paper contains lengthy numerical tables of the energy, expressed both in foot-pounds and in kilogrammetres, stored up in boilers containing given weight of water or steam at given pressures. According to these calculations a Lancashire two-flue boiler holding three tons of water working at 37 lbs. of steam pressure would, by its explosion, liberate sufficient energy to blow itself nearly 2½ miles high, with an initial velocity of 900 feet per second.—E. J. Houston, glimpses of the International Electrical Exhibition, Nos. 2 and 3. These papers give accounts of Dolbear's electrostatic system of telephony, and of Gray's telephonic inventions, with numerous illustrations.—L. d'Auria, the earth's ellipticity; a reply to Prof. Chase.—Standard sizes of belt heads and nuts, a reply by Mr. Coleman Sellers to Mr. Simmonds.

SOCIETIES AND ACADEMIES

London

Royal Society, Nov. 27, 1884.—"Notes on the Microscopic Structure of some Rocks from the Andes of Ecuador, collected by E. Whymper. No. V. (conclusion). Altar, Illiniza, Sincholagua, Cotocachi, Sara-urcu, &c." By Prof. T. G. Bonney, D.Sc., F.R.S.

The microscopic structure of rocks from the first four of these mountains was described, the specimens being less numerous than in some of the former cases. Altar, Sincholagua, and Cotocachi furnished augite-andesites, mostly hypersthenifierous; Illiniza, micaceous and hornblendic augite-andesites. Sara-urcu was not a volcanic mountain, the specimens all being metamorphic rocks, varieties of gneiss and schists, similar to those which occur among the less ancient metamorphic rocks of the Alps and the Scotch Highlands; hence, probably, Archæan, but not the very oldest Archæan. A few miscellaneous specimens were also described, and the paper concluded with some general remarks and a summary of results.

January 15.—"On the Chemical Composition of the Cartilage occurring in certain Invertebrate Animals." By W. D. Halliburton, M.D., B.Sc. (Lond.), Sharpey Physiological Scholar, University College, London. Communicated by Prof. E. A. Schäfer, F.R.S. (from the Physiological Laboratory, University College, London).

At Prof. Lankester's suggestion I have submitted to chemical analysis the cartilages occurring in Sepia and in Limulus.

The basis of the cartilage is a chondrin-like body which gives the reactions of mucin and gelatin (indeed, chondrin, as it occurs in the ordinary hyaline cartilage of Vertebrates, is now regarded by many as a mechanical mixture of these two bodies). But in the cartilages of the two Invertebrates in question the gelatinous element is exceedingly small, and no gelatinisation occurs on the cooling of the hot watery extract.

In addition to this, however, the cartilage of both these animals differs from that of Vertebrates in containing a certain small percentage of chitin. In the case of Limulus 1·01 per cent., and of Sepia 1·22 per cent., of chitin, in the dry state is present.

I have also demonstrated that chitin exists in the liver of the king crab, though whether in the connective tissue or in the liver cells themselves I cannot say. (The connective tissue element is very abundant in the liver of this animal, and it seems probable, looking at the part that chitin plays as a supporting structure in these animals, that it really forms in this instance a partial basis for the connective tissue.)

The way in which chitin was demonstrated to exist was the same in all three cases, viz.:—

(1) After digesting with potash, a residue insoluble in boiling alkalies remains behind.

(2) This residue, which, when washed and dried, is obtainable in a white amorphous condition, is insoluble in weak acids; but in concentrated mineral acids it is soluble in the cold.

(3) On boiling the solution in sulphuric acid, a body which has the power of reducing cupric salts is formed.

(4) On boiling the solution in hydrochloric acid it turns brown, and on evaporating this solution to dryness a body crystallises out which has all the properties of hydrochlorate of glycosamine.

(I prepared some of this body from the chitin contained in the exoskeleton of cockroaches, and also obtained from Prof. Lankester some crystals of the same body which Prof. Gamgee had kindly sent him.)

I was (thus) enabled to compare the crystalline body I had obtained from the invertebrate cartilage with that of the pure hydrochlorate of glycosamine, and they were found to agree in the following points:—

(*a*) Crystalline form: rhombic prisms of the monoclinic system; measurement of the angles gave the same result in all cases.

(*b*) Action of polarised light: *nil*.

(*c*) Solubilities: easily soluble in water, soluble with difficulty in alcohol.

These results are especially interesting as showing that chitin is not a body which is exclusively epiblastic in origin, but in these three instances at least occurs in mesoblastic structures.

Mathematical Society, January 8.—J. W. L. Glaisher, F.R.S., President, in the chair.—Messrs. F. R. Barrell, S. O. Roberts, and Prof. M. N. Dutt, St. Stephen's College, Delhi, were elected members. The Rev. T. C. Simmons was admitted into the Society.—Prof. M. J. M. Hill read a paper on the differential equations of cylindrical and annular vortices.—The Rev. R. Harley, F.R.S., spoke on criticoids.—The following further communications were made:—Multiplication of symmetric functions, by Capt. Macmahon, R.A.—Note on symmetrical determinants, by A. Buchheim.—Results in elliptic functions, by the President (J. J. Walker, F.R.S., Vice-President, in the chair).—Mr. Tucker read a second note by Prof. Cayley, F.R.S., on the binomial equation $x^p - 1 = 0$: quinquisection, and communicated a second paper, by H. MacColl, on the limits of multiple integrals.

Victoria Institute, January 19.—A paper on the historical evidences of the Abramic migration was read by Mr. W. Boscarven, in which he gave extracts from the new translations of some tablets which had been discovered by Mr. Rassam during his last visit to the East. These extracts contained a large number of names of persons and cities mentioned in the Bible record of the times to which they referred.

Edinburgh

Royal Society, January 5.—E. Sang, LL.D., Vice-President, in the chair.—Mr. Harvey Gibson submitted a paper on the anatomy of *Patella vulgata*.—Mr. W. W. J. Nicol read a paper on a theory of solution. Solution of a salt in a liquid results from the attraction of the molecules of the liquid for a molecule of the salt exceeding the attraction of the molecules of salt for one another. Saturation ensues when these attractions are balanced. The theory explains variation of solubility with rise of temperature. Mr. Nicol brought forward experimental evidence in support of his views.—Mr. H. R. Mill, chemist to the Granton Marine Station, read a paper on the salinity of the water of the Firth of Forth. Results were given, showing the variation of salinity along the Firth for high and low water.

Paris

Academy of Sciences, January 12.—M. Bouley, President, in the chair.—Thermo chemical experiments with phosphorous fluoride, a new gas recently discovered by M. Moissan, by M. Berthelot.—Anatomical description of *Ganidia Garnotii*, Payrandeau, a species of Ganidia very abundant on the coast of Algeria, by M. de Lacaze-Duthiers.—Report on M. Luvini's two memoirs dealing with the formation of hailstones and the development of electricity during thunderstorms, by the Commissioners, MM. Becquerel and Faye.—On the formation of toxic alkaloids in cholera patients, by M. A. Villiers. Experiments made on two victims of cholera soon after death enabled the author to determine the presence of an alkaloid clearly characterised by its alkaline and chemical reactions. It is found chiefly in the intestine, and also in small quantities

in the region of the loins, but is completely absent from the blood and liver. Its study may yield important results for the treatment of cholera, and must possess great interest for toxologists.—Observations of Encke's comet made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan.—Note on the theory of periodic transformations, by M. S. Kantor.—On some partially-derived linear equations of the second order, by M. Lucien Levy.—On the simultaneous effects of rotatory force and of double refraction, by M. Gouy. The author finds that these effects are in every respect conformable to those resulting from the hypothesis of Airy, that they may be completed by determining the values of K and δ, and generalised by extending them to other mediums besides quartz.—Action of boric acid on some coloured reagents, by M. A. Joly.—On the hydrates of the sesquichloride of chromium, by M. L. Godefroy.—On the alkaline ferrocyanates and their combinations with the chlorohydrate of ammoniac, by MM. A. Etard and G. Bemont.—On a combination of acetic ether and the chloride of calcium, by M. J. Allain-Le Canu. An analysis is here given of this compound, which was first indicated by Liebig.—On three new compounds of iridium, yielded by the combination of the perchloride of iridium, $IrCl_4$, with the hydrochlorates of mono-, di-, and trimethylamine, and corresponding in their composition to the chloro-iridate of ammoniac, by M. C. Vincent.—On various haloid derivatives from substitutes of propionic acid: chloruretted and ioduretted derivatives, by M. L. Henry.—On the significance of the polarimetric experiments made with the solution of cotton in Schweizer's liquid, by M. A. Béchamp.—On the influence of sunshine on the vitality of the germs of microbes, by M. E. Duclaux. From experiments made with *Tyrothrix scaber*, cultivated in milk and Liebig's extract, the author finds that the light of the sun is fifty times more destructive than its heat, and its hygienic properties are thus fully confirmed.—Studies on the head and mouth of the larvæ of insects, by M. A. Barthélemy.—On some points in the anatomy of the Cidaridæ of the genus Dorocidaris, by M. Prouho.—On a marine Hemiptera, *Æpophilus Bonnarei*, Signaret, by M. R. Koehler.—On a veinous cirrhosis-determined in the rabbit by *Cysticercus pisiformis* (Auct.), and in connection therewith on the embolic origin of certain gigantic cellules, by M. Laulanié.—On a disease of the carob plant causing hypertrophy of certain parts analogous to the so-called malady of "la loupe" in the olive, by M. L. Savastano.—On the actual value of the magnetic elements at the Observatory of the Parc Saint-Maur, by M. Th. Moureaux.—On the earthquakes that occurred in Andalusia on December 25, 1884, and the following weeks, by M. Macpherson, with remarks by M. Daubrée.—On the ascending movement observed in certain waterspouts, by M. E. Vibert.

Berlin

Meteorological Society, December 2, 1884.—Dr. Lœwenherz, after briefly sketching the history of the invention of the thermometer and the early improvements made on it, showed a large number of different constructions of the column and the inclosure thermometer for meteorological purposes, comprising the common as well as the maximum and minimum thermometer, and, in concluding his address, discussed the production of thermometers, the successive stages of which he illustrated by bringing forward glasses connected respectively with these.—Dr. Vettin spoke on the observations of clouds, and described an apparatus for measuring their height. Suppose the cloud projected to a distance of four miles, it then possessed at that distance a "projected" speed, in its actual height it possessed the actual speed, and from these two data the actual height could be calculated according to the proportion; the projected height H is to the actual height h as the projected speed C is to the actual speed c. The actual speed was measured by Dr. Vettin from the movement of the shadows of clouds, which he could in most cases determine directly by means of the sharp edges of the shadows cast on a large field of vision, where the objects and their distance from each other were known to him. In the case of cirrus clouds, again, the wandering of the darker and brighter spots along a street could mostly be determined likewise with the help of a time piece. For the purpose of determining the projected speed, Dr. Vettin made use of a special apparatus, a longish *camera obscura*, containing a lens which projected the image of the cloud on an inclined mirror, which in turn reflected the image on a dim glass plate at the side of the apparatus. This plate was round, and had scratched into it at its periphery a circular division, at which the movement of the cloud-image from the centre towards the periphery along a determined radius was measured. From the observed time and the inclination of the apparatus, with the help of tables calculated by Dr. Vettin, the projected speed could readily be found. Another method of measuring the height of clouds consisted in determining the angle of the last ray after sunset, or the first ray before sunrise, falling on a definite point of the cloud formed with the horizon. Besides the tables referred to in the first method described, Dr. Vettin had drawn up tables for ascertaining this angle from the observed time and for calculating the height of the observed cloud-point.—In accordance with earlier data adduced by Dr. Vettin, Prof. Boernstein showed two experiments which brought into beautiful exhibition the process by which ascending whirling currents of air were generated. A glass plate, on which stood a high glass bell, was covered with a layer of tobacco-smoke, which was heated from below by a small flame applied near the centre. At once arose an upright column of smoke, which broadened at the top and recurved outwards and downwards so as to form a beautiful whirl. In the second experiment a closed glass case was set on a rotatory apparatus capable of imparting to it a revolution such as the earth possessed on the northern hemisphere, or the reverse. The bottom of the glass case was warmed at a place of circumscribed area, from which arose a softly-ascending current of air analogous to that of the first experiment. If the case were now put in uniform rotation, and if, by means of a tube running through the lid down to the bottom of the case, tobacco-smoke were blown into it, so soon as the smoke came in contact with the heated place, a whirl was formed, and the smoke mounted upwards in the shape of a spiral, which, under a rotation of the case similar to that of the northern hemisphere, was in a direction opposed to the rotation of the hands of a clock. On the other hand, if the case rotated in a manner corresponding with the rotation of the southern hemisphere of the earth, the whirl of tobacco-smoke and the ascending spiral rotated in the direction of the hands of a clock. These simple and very instructive experiments may easily be performed if too much smoke be not admitted into the closed space and if the part heated at the bottom of the case be restricted to little more than a mere point.

CONTENTS

THURSDAY, JANUARY 29, 1885

THE STABILITY OF SHIPS [1]

A Treatise on the Stability of Ships. By Sir E. J. Reed, K.C.B., F.R.S., M.P. (London: C. Griffin and Co., 1885.)

II.

IN simplifying the mode of presentation of the scientific principles which govern the stability of ships, Sir E. J. Reed touches upon a very important point—the defects of nomenclature. The technical nomenclature of naval architecture has gradually been formed in an unsystematic and often heedless and unintelligent manner; and it contains many inconsistencies and inaccuracies. Attention has previously been called by ourselves and others to the subject. Sir Edward Reed refers to the confusion that is sometimes caused by giving the name "metacentre" to points upon two curves which are quite distinct from each other. One of these curves indicates the variation in the height of the metacentre with draught of water when the ship is upright; and the other is that formed by the intersections of consecutive normals to the curve of buoyancy as a ship becomes inclined from the upright. These two curves are entirely different in character, and have only one point in common—viz. the metacentre for the upright position corresponding to the draught of water for which the curve of intersections of consecutive normals is constructed. The latter curve is, of course, the evolute of the curve of buoyancy. Sir Edward Reed proposes to call the intersections of consecutive normals to the curve of buoyancy at all angles of inclination from the upright "pro-metacentres," and to restrict the use of the term "metacentre" to indefinitely small inclinations from positions of equilibrium.

The points described as "pro-metacentres" are centres of curvature of the curve of buoyancy. They are but of little importance to practical naval architects, and are probably never regarded by them. To persons who may be pursuing investigations in which such points require to be dealt with, such a term as "pro-metacentre" may be of use. Sir Edward Reed truly says that the points in question "are not 'meta-centres,' except in a very strained, misleading, and wholly exceptional sense." They do not enter into any of the considerations by which the stability of a ship is judged of or calculated; and their positions are not determined, nor even known, in practice.

If Fig. 2 represents the section of a ship, $B\,B_3$ the curve of centres of buoyancy, and $M\,M_3$ the curve of intersections of consecutive normals to $B\,B_3$, or the evolute of $B\,B_3$, then the points M_1, M_2, and M_3 will be the "pro-metacentres" corresponding to those angles of inclination at which $M_1\,B_1$, $M_2\,B_2$, and $M_3\,B_3$ are respectively vertical. M is the point corresponding to the position of equilibrium when the vessel is upright, and is the metacentre proper. Such points as M_1, M_2, and M_3 have sometimes been miscalled metacentres, and the curve $M\,M_3$ the metacentric evolute. Sir E. J. Reed proposes to call these points "pro-metacentres," and the curve $M\,M_3$ the "curve of pro-metacentres." M_1, M_2, and M_3 are centres of curvature of $B\,B_3$ at the points B_1, B_2, and B_3; and the curve $M\,M_3$ is the evolute of $B\,B_3$.

Sir Edward reminds us that the points where the lines $M_1\,B_1$, $M_2\,B_2$, and $M_3\,B_3$ intersect the vertical axis of equilibrium through B, have sometimes, in this country, been called "shifting metacentres"; and he considers that although this term has a "measure of justification, its use is not very desirable, and is, indeed, likely, unless great care is taken, to introduce misconceptions into the subject." It is true that the term "shifting metacentre" was suggested for application to these points, even by so eminent an authority as the late Prof. Macquorne Rankine; but it has failed of its purpose, and passed so completely into oblivion that if Sir Edward had not referred to the circumstance few of his readers would have remembered it. There is little probability of the term "shifting metacentre" now coming into use.

The most natural mode of treating these points is doubtless to class them all in the category of "metacentres," without any qualifying adjective of a general character, such as "shifting." In France the term metacentre includes the point M—which we regard as being the metacentre proper—and Prof. Rankine's shifting metacentres. It is natural to regard the intersection of $M_2\,B_2$

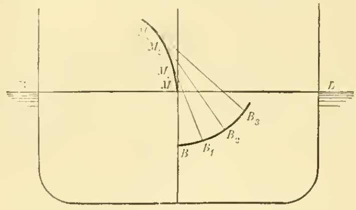


FIG. 2.

with the vertical axis of equilibrium as the metacentre for the particular angle of inclination to which $M_2\,B_2$ relates. This is quite consistent with Bouguer's original definition of the metacentre, viz. "la terme que la hauteur du centre de gravité G, ne doit pas passer, et ne doit pas même attendre." This point constitutes the limit above which the centre of gravity cannot be raised without causing the ship to move farther away from the upright, whether the angle of inclination be great or small. It is convenient, and need not be ambiguous, to call these points metacentres for the particular angles of heel to which they relate. Thus the intersection of $M_1\,B_1$ with the vertical axis of equilibrium through B is the metacentre at 10° of inclination, if 10° be the angle at which $M_1\,B_1$ is vertical; and the same for any other angle.

These points are really of importance to the naval designer, as the distance from such a point to the centre of gravity at any angle of inclination, say 30°, is equal to the length of the ship's righting lever divided by the sine of the angle of inclination. If this distance be zero the righting lever vanishes, and there will be no resistance to further inclination. If the metacentre at 30° fall below the centre of gravity the ship will tend to incline still

[1] Continued from p. 240.

farther; but if it be above the centre of gravity she will tend to return towards the upright position. Sir Edward Reed objects to calling these points metacentres when the angles of inclination are large, because they really have "nothing to do with limiting the height to which the centre of gravity can be raised without disturbing the upright position of the ship." We do not see that any such property is implied by calling the metacentre for a certain angle of inclination the metacentre belonging to that inclination, which is what the French do. There is no doubt that the French method is a natural and useful one. It is also one which has been adopted by many in this country, and is likely to become general. M. E. Bertin, of Brest, says that the nomenclature adopted throughout France for many years past has been such as to leave no room for difficulties of interpretation. But while Sir Edward Reed objects to the French practice in this respect, as well as to Prof. Rankine's "shifting metacentre," he does not propose a substitute for either.

There are other matters connected with the nomenclature of this branch of science which might have been profitably dealt with by the author. Take, for instance, the common use of the term stability. The stability of a floating body is determined by the forces which resist its angular motion from a position of equilibrium, and by the angular distance over which such forces operate. What is called the curve of stability is a curve of which the abscissæ denote angles of inclination and the ordinates are proportional to the righting moments. This may quite properly be called a curve of stability, as it gives a complete graphic representation of the various elements of stability. But the righting moment possessed by a ship at a given angle of inclination is frequently called the statical stability at that angle: while, by a still stranger misuse of scientific language, the work required to be done to incline her from the upright position of equilibrium to the angle in question is called the *dynamical stability* at that angle. Stability exists only at positions of equilibrium; and it is absurd to speak of foot-tons of stability at a given angle of inclination from one of those positions, as is frequently done. Such mistakes can only be due to the confusion which exists in many minds between stability and righting moment. Prof. Osborne Reynolds called attention to the point at the meeting of the British Association in 1883. Whether any intelligible meaning is supposed to be conveyed by the words "dynamical stability developed during inclination," we do not know; at any rate, we cannot discover what it is. Sir E. J. Reed has done good service by approaching the question of mistaken and ambiguous terms in naval architecture. We are only sorry that he has not dealt more thoroughly with it.

Sir Edward gives numerous illustrations of curves of metacentres, and curves of stability, for various types of ships; so that the effect upon them of variation in the proportions and form, and also in the loading, of various types of vessels, may be studied. These curves are given for broadside armour-clads, low freeboard turret-ships, and armoured cruisers of our own and other navies; and for passenger and cargo steamers. The latter include examples which show the character of the stability that many vessels of the "well-deck" type possess.

The subject of longitudinal stability is fully dealt with; and the effect of admitting water into a watertight compartment is discussed. The method of determining the height of the longitudinal metacentre is explained; and also the moment required to alter the trim of a given ship by a fixed amount. The changes of trim produced by putting weights into or taking weights out of a ship are clearly described. The stability of a vessel fitted with watertight compartments, and having water admitted into one or more of them by collision, or otherwise, is investigated with great fulness of detail. The following distinct conditions are considered: (1) When a closed compartment is completely filled with water; (2) when a closed compartment is partially filled with water; and (3) when a compartment contains water in free communication with the sea, and in which the water maintains the same level as the sea for all inclinations. In dealing with this subject Sir E. J. Reed substantially follows the lines laid down by Mr. F. K. Barnes, of the Admiralty, in papers read before the Institution of Naval Architects in 1864 and 1867. Mr. Barnes has very ably and lucidly explained the effect upon the metacentric height which is produced by laying a central compartment in a ship open to the sea and filling it with water; and also the effect produced by thus filling compartments which are formed by longitudinal bulkheads. The results are given, in both cases, for compartments of various sizes and proportions.

Sir Edward devotes a chapter to the consideration of "dynamical stability," and gives the views that have been put forward respecting it by the late Canon Moseley and by MM. Moreau, Bertin, Risbec, and Duhil de Benazé. He also quotes an interesting and ingenious investigation by M. Guyou, of the French Navy, which includes a somewhat novel treatment of the problem of dynamical stability. We have already objected to the use of the phrase "dynamical stability." The author explains that what is called the dynamical stability at a given angle of inclination is the work done by an inclining force in heeling the ship from the upright position of equilibrium through that angle. The "total work is the dynamical stability." Dynamical stability is consequently spoken of as being "developed during the inclination of the ship from one angle to another." Resistance is overcome, and work is done, in inclining a ship from one angle to another against the action of righting forces; but we cannot understand why such work should be called "dynamical stability."

The work done in inclining a ship from one angle to another is, of course, the resistance to such inclination multiplied by the distance through which the resistance is overcome. This resistance is constituted by the weight of the ship acting vertically downwards through its centre of gravity, and an equal and opposite force acting vertically upwards through the centre of gravity of the displaced water. Therefore the total work performed during an inclination is the weight of the ship multiplied by the vertical increase of distance between the centre of gravity of the ship and the centre of gravity of the displaced water.

This treatise contains an instructive chapter upon M. Amsler-Laffon's mechanical integrator. The ordinary pivot-planimeter, which is a more common and very valu-

able instrument, is not referred to; but the integrator which combines appliances for computing areas, moments, and moments of inertia of plane curves is described. This instrument has lately been introduced into ship-drawing offices, and is highly appreciated for the saving of time and labour which can be effected by its use, and for its comparative freedom from error. Complicated calculations can be made with this ingenious piece of mechanism by less highly-skilled draughtsmen than are required for performing the ordinary arithmetical calculations. This is a very important matter in mercantile shipyards, where the supply of scientifically-trained draughtsmen is not great. In referring to this point Sir E. J. Reed says that "in most private shipbuilding establishments these lads (drawing-office apprentices) are now required to pass an examination similar to that which candidates undergo for apprenticeship in Her Majesty's dockyards." We do not understand that this is so. It may be the case with one or two firms, but the system is a very exceptional one. Sir E. J. Reed gives a mathematical investigation of the properties of the integrator, and explains how to take off the readings for areas, moments, and moments of inertia. We notice an omission in connection with the figures given for the various constants that require to be applied as multipliers to these readings, for the purpose of converting them into actual units of measurement. The particular instrument to which the constants apply is not fully stated. The constant for areas, given as 15, and that for the area term in the expression for moment of inertia, given as 240, relate to instruments formerly supplied by M. Amsler, which had a different diameter of area wheel from those now made. We believe that the circumference of the area wheel is now 2·5 inches; so that the two constants which depend upon the size of the area wheel would, in that case, be 20 and 320, instead of 15 and 240.

The final chapters of the treatise deal with general questions relating to the rolling of ships at sea, and the effect of wind-pressure upon stability when ships are sailing among waves. The method of obtaining by experiment the vertical position of a ship's centre of gravity, and the precautions which have to be adopted in order to ensure fairly accurate results, are described.

The few omissions and defects we have pointed out are but of minor importance, and do not appreciably affect the general value of this very important treatise. It is not only the largest that has ever appeared in this country, but also the most intelligible, instructive, and complete exposition of the principles of stability. It forms a most valuable addition to the science of naval architecture, and one that has long been needed. Till now we have been unable to refer persons desirous of studying the various problems connected with the stability of ships to any work in which they would find the subject treated in a clear and comprehensive manner. Sir E. J. Reed has supplied a want that has long existed. We strongly recommend his book to all who are interested in the subject, and particularly to those whose connection with ships requires them to know upon what conditions stability depends, and how it is affected by all the various circumstances of construction and loading which may arise. Such a treatise should be especially welcome to students.

OUR BOOK SHELF

In the Lena Delta; a Narrative of the Search for Lieut.-Commander De Long and his Companions, followed by an Account of the Greely Relief Expedition and a Proposed Method of Reaching the North Pole. By G. W. Melville; Edited by G. Melville Philips. (London: Longmans and Co., 1885.)

THE sad story of the *Jeannette* Expedition has already been very fully told in the two volumes of journals left by Capt. De Long. Still, we do not object to this more detailed narrative of the experiences in the Lena Delta of those who managed to reach it, by the one most qualified to speak of them. It was by the strenuous exertions of Engineer Melville that the bodies of Capt. De Long and his companions were discovered, and that the few survivors were rescued. Concerning the physical and biological conditions of the great swamp formed about the mouths of the Lena, Mr. Melville does not tell us much more than we knew already; but his continual journeys to and from between the delta and such towns as Yakutsk, Tiumen, and others in this part of Siberia necessarily furnish us with many details of interest. As a story of remarkable adventures the book is certainly interesting. Mr. Melville's arctic enthusiasm was not in the least damped by the *Jeannette* misfortunes. Not only does he describe in the present volume his experiences as a member of the Greely Relief Expedition, but he means evidently to attempt to reach the Pole, if for no other reason but that it "may prevent other fools from going there." Mr. Melville's plan takes for granted that Franz Josef Land reaches to 85° N., which is probable enough; and he would therefore propose to utilise this as a basis of operations; around the Pole he supposes that a partial "vacuum" exists, and that partly as a consequence the ice-cap there is immovable, held in its place by the islands which he believes surround it. As to getting back when the Pole is reached, Mr. Melville believes that this could easily be effected either by Nova Zembla or Spitzbergen. Of course, the retreat would be secured by the establishment of carefully-selected depots. "Finally, I propose to prove this theory of reaching the North Pole by *going there myself.*" Every one will wish him God speed; and there can be no doubt that the best arctic authorities are agreed that the next expedition should seriously try the Franz Josef Land route.

Stanford's Compendium of Geography and Travel—Europe. By F. W. Rudler, F.G.S., and G. W. Chisholm, B.Sc. Edited by Sir Andrew C. Ramsay, LL.D., F.R.S. With Ethnological Appendix by A. H. Keane, M.A.I. (London: Stanford, 1885.)

THIS many-authored and much-edited volume is the last of the series of Stanford's well-known "Compendium," the first volume of which was issued some six years ago. That first volume dealt with Africa, and was edited, it may be remembered, by Mr. Keith Johnston, who shortly after publication lost his life attempting to explore the continent which he had so well described. There have been subsequent editions of that volume edited by Mr. E. G. Ravenstein. The succeeding volumes were South America, by Mr. H. W. Bates; Australasia, by Mr. A. R. Wallace; Asia, by Prof. Keane and Sir Richard Temple; and North America, by Drs. Hayden and Selwyn. It will thus be seen that Mr. Stanford has been fortunate in his choice of editors for the several volumes. The Compendium professes to be based on Hellwald's German work, but it may throughout be regarded as virtually original. The various editors have put so much of their own into their several volumes, and given to the whole an orientation so essentially English, that it would be difficult to tell which is Hellwald and which the "editors." In the present volume the editors and authors (or one of them, for the title-page is awkward) have wisely

retained what Hellwald says concerning the English people.

The volume is quite equal to the best of its predecessors. The physical geography of Europe occupies quite one-half, and while necessarily of the nature of a summary, seems to us carefully and accurately written. The second part of the volume is devoted to what is known as "political" geography, while Mr. Chisholm has collected into an appendix a very useful series of statistical tables. As usual we have Prof. Keane's valuable ethnological appendix, occupying some thirty pages. Though Europe is the best-known of the Continents, its ethnology is more difficult to deal with than that of any other part of the world. "Races" and languages have become so mixed up and interchanged, that it is a matter of great difficulty to distinguish between the various elements. Mr. Keane has some difficult problems to face, but probably no one is more competent to solve them. His sections on "pure races" and "mixed languages" are of special interest; he rightly concludes that in Europe we have neither the one nor the other, nor probably will they be found in any part of the world. These ethnological appendices are quite worthy of being collected and extended and published separately as a useful manual of ethnology. The maps in the present volume are many, and of much scientific value. This "Compendium" as a whole may be accepted as a really trustworthy and manageable geographical reference-book.

Nine Years in Nipon; Sketches of Japanese Life and Manners. By Henry Faulds, L.F.P.S. (London: Alexander Gardner, 1885.)

THE author of this beautiful and entertaining volume is a missionary doctor who, in the course of his nine years' residence in Japan, has, as he tells us, mixed with every class in the country except the very highest. He has visited most of the usual sights, such as Fuji, Nikko, and the inland sea, but otherwise his professional duties appear to have kept him very close to Tokio. To make up for this he has seen the lower and middle classes of Japan as few other Europeans have had the opportunity of seeing them, and after all he is able to say that the land is not all barren. He stands up bravely against the redoubtable Miss Bird for the much-maligned morality of the Japanese people. He thinks that brilliant lady's dictum that the nation is sunk in immorality extremely harsh and erroneous. The recent intellectual progress of the Japanese is, he believes, very striking, though not as yet so general as many have supposed; their political progress is unprecedented, but he thinks that on the whole the moral elevation of the mass of the people within the last decade has been still more striking and noteworthy. A considerable portion of the volume is made up of bright, lively sketches of scenes by the way in Tokio, and along the roads in the interior. These are very well done, but they might almost be equally well done by an ordinary tourist with some literary gifts and graces. It is in the last half of the volume that we come on the real student and acute observer of Japan. It is only an old resident, whose familiarity with the everyday sights and sounds around him had never blunted his original sense of their picturesqueness and strangeness, that could have written the chapters on the Japanese philosophy of flowers, Japanese art in relation to nature, and how the Japanese amuse themselves. In connection with the universal spread of education throughout Japan (the author can only recall one or two clear instances in his experience of Japanese people being unable to read or write), he makes an observation which we do not remember to have seen or heard before, viz. that the cause is Buddhism. The effect of what he calls the new and genial enthusiasm of humanity, which came from India, taught everywhere the unity and brotherhood of man, and so literature could no longer be maintained as the peculiar possession of any caste of mere priests or princes. "My Garden and its Guests" is a delightful chapter of popular natural history. In an introductory chapter, in which he surveys the canvas on which he is about to draw his sketches, he has a few words to say on the ethnology of the Japanese. He says that the Ainos, "in spite of a great deal of crude writing on the subject" (to which, it should be stated, Mr. Faulds has added his mite, though not in this book), cannot show any claim to be considered the aborigines; they are not necessarily older in their occupancy than the Japanese themselves. This heterodox statement is thrown off with a *nonchalant* air, as of one making a common matter-of-fact observation; but it would be interesting to know the author's grounds for it. The shell-heaps (to take only a single instance) which have been found near Tokio, and even farther south, and which resemble in every respect heaps formed, or in process of formation, outside Aino villages in Yezo, form a strong argument the other way; we were under the impression, also, that history told us of the existence of Ainos on the spot on which Ota Dokan built himself the fort which afterwards grew into Yedo in the fifteenth century. But it seems waste of time to refer to such matters in the case of a man who has the hardihood to confess that he does not know exactly what a Mongol is, and that he thinks it only deepens our ignorance immensely to call another race Mongoloid. To make up for this, however, and by way of washing his hands clear of the matter, he gives all the original theories by which science, aided by tradition, accounts for the original migration of the Japanese people. As there are six points of the compass (zenith and nadir being added) in far-eastern cosmography, so there are theories of migration from each one of these six points:—(1) the soil (Buddhist view); (2) America; (3) China, or Accadia; (4) Africa, or the Malay Peninsula, or the Southern Isles of the Pacific; (5) Saghalin, or Kamtschatka; (6) the celestial regions of the Sun; with which comprehensive category Mr. Faulds takes leave of ethnology. For the rest, the book is as charming in all externals as in its contents. It should take its place in the front rank among popular books on Japan; indeed, since Mitford's "Tales of Old Japan," we cannot recall a more interesting volume on the country, or one which should be more read in England.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Krakatoa

BY the return from the Caroline Islands, on the 25th inst., of the *Jennie Walker*, I am enabled to supply a few additional details about the westward progress of the equatorial smoke stream from Krakatoa in September 1883. In NATURE, October 2 (p. 537), is my extract from Miss Cathcart's journal describing the obscuration of the sun at Kusaie, or Strong's Island, on September 7, 1883. The Rev. Dr. Pease and wife came as passengers by the *Jennie Walker*. They state that, while they were dressing their children on the morning of September 7, the natives came anxiously asking what was the matter with the sun, which rose over the mountains with a strange aspect. It was cloudless, but pale, so as to be stared at freely. Its colour Dr. Pease called a sickly greenish-blue, as if plague-stricken. Mrs. Pease's journal described it as "of a bird's-egg-blue, softened as this colour would be by a thin gauze." Around the sun the sky was of a silvery gray. At the altitude of 45° the sun appeared of its usual brightness, but resumed its pallid green aspect as it declined in the west.

On the 8th the sun appeared as usual. They did not notice the red glares until some days after.

Strong's Island is in lat. 5° 20′ N., long. 163° 10′ E. Their 7th is our 6th, one day later than the tremendous display of colours in the Honolulu skies on September 5.

Dr. Pease reports a considerable drift of pumice-stone landed for several months past upon the *west* shore of Kusaie. Many pieces are from twelve to sixteen inches thick, and loaded with barnacles. I have now before me a piece of pumice presented by Dr. Pease, with small barnacles attached. Dr. Pease also reports many large trees landed there of late. They are up to five feet in diameter, with huge buttressing roots, much pumice jammed in the roots, their wood as light as cork. This species of tree is unknown in Micronesia. Are these corky trees, as well as the pumice, part of the wreckage of Krakatoa? Dr. Pease states that this year, as happened once before, the prevailing westerly current has been exchanged for one running easterly. Drift-logs of redwood from California frequently land on Kusaie, as they do here.

On the passage hither between Kusaie and Jaluit Dr. Pease saw large tracts of floating pumice in a comminuted state. The Rev. E. T. Doane of Ponape (lat. 6° 47′ N., long. 158° 20′ E.) writes me that large quantities of pumice are floating around that island. Capt. Holland, of the *Jennie Walker*, states that all the way between Jaluit and Ruk or Hogolen, some 1500 miles, he encountered vast tracts of pumice. Many pieces were as large as hats. He met five or six large trees in the same regions. One with its branches was mistaken for a boat. This association of floating trees with pumice seems very suggestive of Krakatoa, especially as all have been long floating in the sea.

I send herewith a small slab of the pumice from Strong's Island, hoping that you will have it compared with known Krakatoa ejecta.

During the past month of December the sky-glows have doubled in brightness. A like augmentation of brilliancy took place at the same period in 1883, as reported by me in your columns. Permit the suggestion that the winter cold enlarges the concretions of ice around the dust-nuclei in the upper atmosphere, thereby multiplying their reflecting power. I see no reason to believe that any addition has been made to the original diffusion of dust from Krakatoa. The whitish corona which first appeared around the sun in September, 1883, has always and continuously been conspicuous since that time. It is one and the same continuous phenomenon which began here with that tremendous dust-cloud of September 5, 1883.

S. E. Bishop

Hawaiian Government Survey, Honolulu, Dec. 29, 1884

Recent Earthquakes

En relation possible, mais non probable, avec les tremblements de terre d'Espagne j'ai à vous signaler les secousses suivantes observées en Suisse :—

25 décembre, 1884—à Zernetz, Engadine, secousses à 8h. 17′ S., et 11h. S., heure de Berne.

(8h. 17′ heure de Berne correspond à 7h. 32′ heure de Madrid. La première de ces secousses a donc eu lieu 20m. avant la grande secousse de Grenade du 25 déc. à 8h. 52′ soir.)

1 janvier, 1885—2h. matin, légère secousse, signalée à Lausanne par un seul observateur.

21 janvier, 1885—Entre 0h. et 1h. matin, secousse à Ennenda, canton de Glarus.

Dans les Alpes françaises.

le 5 janvier, 1885, à 3h. matin à Chambéry (Savoie).

,, ,, à 5h. 50′ matin à Embrun (Hautes Alpes).

Agréez, Monsieur, l'expression de mes sentiments très distingués.

F. A. Forel

Morges, 24 janvier

On Thursday evening last, at a time which is variously stated from 8.30 p.m. to shortly before 9, a rumbling noise, accompanied by a sensible trembling of the earth, and in some instances by a slight "rocking" of cottages, was heard and felt over several parishes in this neighbourhood. I have already had independent testimony of it from West Buckland, Bradford, Nymhead, and Langford, in a line from north-west to south-east across the upper part of the Vale of Taunton. Some observers state that the noise and motion seemed to come from the north-west. There can be but little doubt but that this was a slight shock of an earthquake. It would be interesting to know whether anything of the same kind had been observed elsewhere at the same time.

W. A. Sanford

Nymhead Court, Wellington, Somerset, January 24

The Lexden Earthquake

The earthquake alleged to have taken place near Colchester on Sunday night, Jan. 18, and mentioned in the "Notes" of Nature last week, on the authority of the *Standard* newspaper, turns out on inquiry to have been reported on very doubtful authority. The place referred to as "Leden" is evidently meant for Lexden, which is really a suburb of Colchester. Immediately after seeing the newspaper paragraph I communicated with some of the residents, asking them to obtain particulars for me, as the occurrence of another shock so near the district which was shaken in April of last year, would have been of considerable interest in connection with the report upon this last earthquake, which I am about to present to the Essex Field Club. It seems, however, according to the results of these inquiries, confirmed by a paragraph in the *Colchester Gazette* of January 21, that the shock was said to have been felt by one person only, the postman, and nobody else in the place heard or felt anything, nor was any crockery shaken or any vibration experienced in any other house. One gentleman, who was out of doors at the time mentioned (midnight), states that he heard a peal of thunder, but felt no shock, and he suggests that this might have awakened the postman, upon whose authority the newspaper paragraph appears to have been founded.

The statement that the shock was felt at Aldeburgh rests also on the authority of one person only, and it shows with what caution such statements should be received in the absence of instrumental records.

R. Meldola

21, John Street, Bedford Row, January 24

Barrenness of the Pampas

Mr. Edwin Clark overlooks, I think, an important factor in the present treeless condition of the Pampas (of the La Plata, so far as my own knowledge extends only), and of the difficulty of establishing trees on those plains. North of Monte Video, for some hundreds of miles, the leaf-eating ant is omnipresent. I have seen streams of them running along the beaten paths to their nests, each ant carrying the yellow petals of some plant similar to the buttercup. When I first noticed, from my horse, this procession of golden leaves, I was greatly astonished. Familiarity, however, soon dispelled this. The *opima spolia* was being carried to their nests and taken under ground, no doubt as a provision for the winter. The ants were about a quarter of an inch in length, and of a beautiful steel-blue colour. Those I picked up for examination demonstrated their powers by shearing off the hard cuticle of my thumb or fore-finger with their mandibles. Subsequently, I made the acquaintance of a gentleman, well known in the Banda Oriental, the owner of the "Estancia Sherenden." He showed me a splendid grove of about two acres of *Eucalypti* of several species—the "blue" and "red" gum chiefly. These he had reared from seed, their enemies being these ants. As soon as the first leaves of his cherished plants appeared, the ants cut them off. He then got a drum of gas-tar sent up from town, and made a circle round each plant. The ants objected to this, and all the trees made a start. For three years in succession he carefully painted the stems with tar, and eventually they got so far away as to be able to supply the wants of their foes and still flourish. When I saw these trees they bore finer foliage than I ever met with in the Australian bush during four years' experience. They were then eight years old. Many were forty feet high, and thirty-six inches round at some three feet from the earth.

I think none of the animals mentioned by Mr. Clarke, *certainly not any of the rodents* in his list, would be likely to touch gum trees, and the repugnance to them of sheep, oxen, and horses in Australia is well known.

Maize grows freely in the Banda, but it grows too fast for these ants to destroy it. The attacks of those from nests within marching distance are powerless on an acre of Indian corn.

When I examined the *Eucalypti* at "Sherenden," many ants were coming down the trees with cuttings of the leaves in their mandibles.

If you will allow me a word of suggestion in addition, I would say to every one who establishes trees on the Pampas

Seek out the nests of these ants within a quarter of a mile (that would be enough), light a good fire over them in winter, when the inhabitants are at home, and after that there would be no difficulty in gradually covering the ground with plantations. The dried stems of the ubiquitous thistle, cow-dung, corn-cobs, or "paja" grass, would burn out these pests.

ARTHUR NICOLS

Cross-Breeding Potatoes

IN the interesting account of the latest successful attempt at raising hybrid potatoes by crossing with different species instead of, as heretofore, by varieties, it is taken for granted the new production will be disease-resisting. Until, however, time has tested the powers of the plant after cultivation, stimulated with all the appliances the potato-growers have at their command, it is rather premature to trust to this. Forty years ago I saw potatoes growing from seed imported direct from South America, and after three years' cultivation they all went with disease in the year 1848. The species I could not tell. The same varieties which go off with disease in this country are never affected in Tasmania, Australia, or New Zealand. At present the newer sorts in cultivation grow so sound and healthy that champions of fine quality over all the east of Scotland are now offering wholesale at three pounds for one halfpenny, and cannot find buyers. The results of the experiments in crossing referred to, while most interesting, will only prove beneficial if a disease-resisting plant is produced having all the table qualities of the old Regent, as well as its great reproductive power, which, with its ability to resist disease, it has now lost.

JAMES MELVIN

43, Drumsheugh Gardens, Edinburgh, January 19

PROTOPLASM[1]

THE fact of a direct continuity between the protoplasmic contents of adjacent cells is an important factor in plant histology. The history of this subject is briefly as follows:—

The individuality of the plant-cells, defended by Schleiden,[2] was first criticised by Hofmeister,[3] and more positively and later by Sachs.[4] For Sachs and also for Strasburger[5] the plant is only one cohering protoplasmic entity. Nägeli[6] has also in a recent work supposed that the protoplasm of each cell is in direct communication with that of the others, by means of delicate protoplasmic filaments.

So far the theoretical side of the question. The first *direct* observation was made in the year 1854 by Theodor Hartig, and not by Sachs as Walter Gardiner[8] states. We find in Hartig's paper the following description of the continuity of sieve-tubes, "Behandelt man in Wasser macerirte Siebröhren mit Schwefelsäure, so erfolgt häufig eine völlige oder theilweise Trennung der beiden Endflächen, in welchem Falle genau zwischen den correspondirenden Ptychodearmen sich Fäden *ausziehen*, die durch Tod dieselbe Färbung und Structur zeigen wie die Ptychodearme selbst. Fig. 18 stellt einen solchen Fall dar."

After Hartig's discovery, confirmed later by Hanstein and Sachs: Mohl, Nägeli, De Bary, Dippel, Wilhelm, Tauczewski, Russow, &c., examined the sieve-tubes and their plasmic connection. For a long time the connection of the sieve-tubes remained the only known fact, until Bornet[1] and E. Perceval Wright[2] in 1878, J. G. Agardh[3] in 1879, and Schmitz[4] in 1883 (the connective filaments were seen), and further, in 1884, Th. Hick[5] and Kolderup-Rosenvinge[6] published some accounts of the communication between adjacent cells in the Florideæ. It seemed to me very probable that in the Cyanophyceæ also communications between the adjacent filament-cells would be found. At least the drawings that Wille[7] gives put one in mind of similar phenomena.

After J. G. Agardh,[8] Tangl,[9] in 1880, succeeded in proving the direct communication in phanerogamous plants between the endosperm cells. In the various papers of Russow,[10] Gardiner,[11] and Hillhouse,[12] these communications are stated in many cases to occur in the bast-parenchyma, the phloem-ray cells of numerous plants, in various pulvini, in the cells of the leaf of Dionæa, in the cells of the stamens of Berberis, in a great number of endosperm cells, and in various cortical tissues.

Finally, Terletzki[13] gave a brief account of the plasmic communication of the parenchyma-cells in the stem of some ferns. I have published also myself[14] a brief account of this interesting object, and described briefly the observations made during the summer of the past year. After Terletzki's paper I was induced to publish my observations, with the full details.[15] The physiological significance of the communication was, in the first instance, not understood; it was believed to be chiefly for the conduction of stimulus in the sensitive organs. But, after numerous observations, there was little doubt that the occurrence of communications between neighbouring protoplasts is not the exclusive privilege of the sensitive organs, and I further claimed the universality of the communication (at least in tissues) in my first paper.[16] This universal occurrence is since confirmed by recent researches.

I have in my second paper[17] given the results of my investigations made on various vegetative tissues. It is superfluous to say anything of the importance of the methods employed in such investigations. For fixing

[1] "On the Continuity of Protoplasm, and on the Protoplasm of the Intercellular Spaces and the 'Middle Lamellary' Protoplasm, with special reference to the Loranthaceæ and Coniferæ," by Dr Jules Schaarschmidt, *privat-docent* of Cryptogamic Botany and the Anatomy of Plants, Assistant at the Botanic Institute and Gardens, Royal Hungarian University at Kolosvár. Contributed by the author.

[2] Schleiden, "Grundzüge der wissenschaftlichen Botanik," i. anfl., 1842-43

[3] Hofmeister, "Die Lehre von der Pflanzenzelle," Leipzig, 1867.

[4] Sachs, "Vorlesungen über Pflanzenphysiologie," p. 102, Leipzig, 1882.

[5] Strasburger, "Ueber der Bau und das Wachsthum der Zellhäute," p 246, Jena, 1882.

[6] Nägeli, "Mechanisch-physiologische Theorie der Abstammungslehre," p. 41, München und Leipzig, 1884.

[7] Hartig, "Ueber die Querscheidewände zwischen den einzelnen Gliedern der Siebröhren in *Cucurbita pepo*," *Botanische Zeitung*, xii. col. 43, 1854.

[8] W. Gardiner, "On the Continuity of the Protoplasm through the Walls of Vegetable Cells." Sachs, *Arbeiten des bot Instituts in Würzburg*, iii. i p. 52, 1884.

[9] Hartig, *l.c.*, col. 43.

[1] Bornet. *Vide* Thuret et Bornet, "Études phycologiques," Paris, 1878.

[2] Wright, "The Formation of the so-called Siphons, and the Development of the Tetraspores in Polysiphonia," *Quart. Journ. Mic. Science*, July 1878; *Transactions* of the Royal Irish Academy, xxvii. 1879.

[3] Agardh, "Florideernes Morphologi," *Stockholm Vet. Akad. Handl.*, xv. p. 140, 1879.

[4] Schmitz, "Untersuchungen über die Befruchtung der Florideen," *Sitz. Ber. d. Kgl. Akad. d. Wissensch.*, p. 219, Berlin, 1883.

[5] Hick, "On Protoplasmic Continuity in the Florideæ," *Journal of Botany*, xxii. p. 33, 1884

[6] Kolderup-Rosenvinge, "Bidrag-til Polysiphonia's Morfologi," *Saertryk af Botanisk Tidsskrift*, xiv. p. 9, 1884, f. 10-14, 26-28, 72, 75.

[7] Wille, "Ueber die Zellkerne und die Poren der Wände bei den Phycochromaceen," *Ber. d. Deutschen Botan. Gesellsch*, i. vi p. 245, 1883, and *Bidrag-til Sydamerikas Algflora*, i.-iii., *Bihang till k. Svenska Vet. Akad. Handlingar*, viii. No. 18, p. 6, 1884.

[8] Agardh, *l.c.*

[9] Tangl, "Ueber offene Communication zwischen den Zellen des Endosperms einiger Samen," *Pringsheim Jahrb. f. wissenschaftl. Botanik*, xii. ii. p. 170, 1880.

[10] Russow, "Ueber Tüpfelbildung und Inhalt der Bastparenchym und Baststrahlenzellen der Dikotylen und Gymnospermen," *Sitz. Ber. Dorpater Naturforschergesellsch.*, p. 350, 1882.

[11] Gardiner, "On Open Communication between the cells in the pulvinus of *Mimosa pudica*," *Quart. Journ. Microsc. Sci.*, New Ser., xxii. p. 365, 1882.

"Some Recent Researches on the Continuity of the Protoplasm through the Walls of Vegetable Cells," *Ibid.*, xxiii. p. 301, 1883.

"On the Continuity of Protoplasm through the Walls of Vegetable Cells," *Proceed. Roy. Soc.*, p. 163, 1883.

"On the Continuity of the Protoplasm through the Walls of Vegetable Cells." Sachs, *Arbeiten d. Bot. Instit. Würzburg*, iii. i. p 52, 1884.

[12] Hillhouse, "Einige Beobachtungen über den intercellularen Zusammenhang von Protoplasma," *Botanisches Centralblatt*, xiv. p 86, 1883.

[13] Terletzki, "Ueber den Zusammenhang des Protoplasmas benachbarter Zellen und über das Vorkommen von Protoplasma in Zwischenzellräumen," *Ber. Deutsch. Botan. Gesellsch.*, ii. iv. p. 169, 1884.

[14] Schaarschmidt, "A protoplastok összeköttetésenek sa sejtközi plasma elöfordulásánat nehány esetéröl," *Magyar Növénytani Lapok*, viii. No. 84, p. 17, February 1884; see Referate in the *Botanisches Centralblatt*, xviii., No. 18, 1884.

[15] Schaarschmidt, "A protoplastok összeköttetéséröl és a sejtközi plasmáról különös tekintettel a Loranthaceákra és Coniferákra," *Ibid.*, No. 87, p. 65, July.

[16] Schaarschmidt, *Botanisches Centralblatt*, xviii. No. 18, 1884.

[17] Schaarschmidt, *Magyar Növénytani Lapok*, viii. p. 77, July 1884.

the freshly-collected materials I used alcohol, osmic or picric acid; all the observations described below were made upon fresh material, treated, after fixing for a few minutes, with strong or dilute sulphuric acid, so as to swell the cell-walls.[1] The fresh material was first cut in alcohol (or osmic or picric acid); the sections were then for a short time placed in a drop of sulphuric acid, and washed rapidly in a watch-glass with distilled water. After washings in several watch-glasses, the sections may be stained. For staining I first used the saffranine, and later solely the eosine (from Dr. Th. Schuchardt, Görlitz, Silesia). The eosine has a great and admirably defined selective staining power. It is a very excellent negative reagent for the cell-wall, and when employed with some precautions colours only or almost only the protoplasm. It is however requisite that a dilute solution of the dye should be made (1 part of eosine to 50-60 parts of water), and that the stained sections should be washed carefully (for ten to fifteen minutes) in water.

That the phenomena detailed below are not artificially produced by reagents is proved in certain instances. The presence of the connecting protoplasmic filaments in the *intact* (not swollen) *normal cell-wall or pit-closing membrane* was witnessed in the medullary cells of the mistletoe, the sections of which were merely mounted in water and stained with eosine.

I now proceed to give an account of the results I obtained with the various tissues in which the continuity of protoplasm was shown to exist.

Epidermis. Glaucium Fischeri gave the first results. In the leaf-epidermis the connecting processes of the protoplasms, many in number (one for each pit), are well defined; the same is the case in that of Viscum and Loranthus, but in the latter plants the fine connecting-threads were also visible. From the protoplasms of the epidermis-cells radiate numerous processes towards the pits, and in any two neighbouring cells the processes from the one protoplast are exactly opposite those proceeding from the other. *All the epidermis-cells*, as in *Ficus elastica*, are in direct communication with one another and with the "guard-cells" of the stomata. The same is also the case *in epidermis composed of several layers*. The connection is very difficult to make out, though visible after a moderate swelling in the *collenchymatic-hypoderm* (Rhus, Cotinus, *Cucurbita pepo*, Solanum, Liriodendron, &c.).

The *bark-parenchyma* is one of the most favourable objects for investigation, and even when the cell-wall has been very conspicuously swollen or dissolved, the connection is unaltered (Loranthus, Viscum, *Abies alba*, *Picea excelsa*, *Gingko biloba*, &c.). When no *hypoderm* exists, the protoplasts of the epidermic-cells should be directly connected with those of the bark-cells. Such is the case in Viscum and Loranthus. The epidermal cell-walls of these plants may have undergone considerable swelling, and so the connective processes become very extended, but the fine connective threads are still conserved. In the *leaf-parenchyma* (Viscum, Loranthus) the connection is very distinct also in the cotyledons of *Phaseolus multiflorus*. It is very difficult to prove the communication in leaves where the parenchyma has been doubly differentiated, viz. into chlorenchyma and into pneumo-enchyma. The *medullary-parenchyma* of Loranthus or Viscum furnish excellent objects for such investigations; the fine bent threads (five to eight in number) can be very *distinctly examined* after a feeble swelling of the cell-wall. In the Coniferæ I find only the connective processes distinct (Gingko, &c.). In the Loranthaceæ the communication is to be directly seen between the *medullary-ray-cells* and *xylem-cells*, between the *phloem-ray-cells* and *bast-parenchyma*; finally between the *medullary-ray-cells* and the *sclerenchyma-cells* [these last are found in the neighbourhood of the xylem (primary) vessels in Viscum.]

[1] See, for details of my method, *Zeitschrift für wissensch. Mikroskopie*, &c., i. ii. p. 301, 1884.

The *bast-fibres* of Viscum, Loranthus, are in direct communication with one another, and in Viscum the fibres of the inner-phloem also communicate with the medullary-cells. The communication between *cambium*, *young bast-fibres*, and *bast-parenchyma*, in the Coniferæ can be demonstrated only with high powers. The communication and connection of the *soft-bast* protoplasts is eminently remarkable. These protoplasts remain in connection even after total dissolution of their cell-walls (Cucurbita, Coniferæ, Loranthaceæ, &c.). I investigated also the sieve-tubes, and have found that these in their entire length are connected with *neighbouring sieve-tubes*, or *bast-parenchyma-cells*, or *collateral cells* (*Nebenzellen*) (Viscum, Loranthus, *Ficus elastica*, &c.). The connective threads are often strongly developed in Cucurbita. They assume the figure of a compressed sphere.

Xylem.—I may remark that the details of the xylem communications are very difficult to observe. In general I have studied the communication of the xylem elements best in the Loranthaceæ, and especially in Viscum. The xylem of the mistletoe is composed of libriform cells, compensating cells (*Ersatzzellen*), and vessels. The cell-walls of the libriform cells are very much thickened, and bear pits only on the middle part of the cell. These cells are variously curved and bent, and offer favourable conditions for investigation—but then the communication of the *libriform cells with one another*, *libriform cells + compensating cells*, and of the latter together can be easily seen. In the Coniferæ the communication of the xylem elements is only clear in the younger states. In the *young tracheides* the distinct threads could be very clearly seen. In the *older tracheides* merely a striation (caused by the threads) could be detected through the pit-closing membrane). As regards the occurrence of a direct continuity, the *xylem vessels* gave generally a negative result. Although in many instances the occurrence of protoplasm in the great xylem vessels could be demonstrated, still direct communications seemed to me to be extremely rare. I could find this direct connection in one instance in Loranthus. The great (but only the pitted) vessels were here connected with the adjacent cells.

Finally, the protoplasts of the secretory cells are also in direct communication with the neighbouring protoplasts, such as in the resin-cannel cells. The cells of the resin-cannels are, in the Coniferæ, directly connected with the adjacent leaf- or bark-parenchyma, or phyllogen-cells. In the bark of Gingko I was also able to confirm the communication of the crystal-bearing cells (crystal-glands) with the bark-parenchyma cells. I have no doubt that the same structure would be equally well demonstrated in the various secretive cells and vessels. In all the observed cases the communication of adjacent protoplasts is effected by delicate wavy protoplasmic threads. The connective thread either in a roundabout way traverses the sieve-pore pit-closing membrane, or directly traverses the cell-wall when the membrane is unpitted or the pits feebly developed. From a physiological point of view the pits form one of the most important arrangements.

The protoplasts are also in direct connection with the intercellular protoplasm. The intercellular plasm which fills the intercellular spaces was first observed by J. G. Agardh[1] in the Florideæ, and by Russow[2] (1882) in various phanerogamous plants. I have (1883) also studied (first in the bark of *Liriodendron tulipifera*) its occurrence in many phanerogamous plants and published my observations in 1884.[3] At this time also Berthold published a paper[4] in which he confirmed its occurrence

[1] *L. c.*, p. 140 &c. [2] *L. c.*, p. 350 &c.
[3] In the *Magyar Növénytani Lapok*, viii. 1884, pp. 19, 74.
[4] Berthold, "Ueber das Vorkommen von Protoplasma in Intercellularräumen," *Berichte der deutschen botan. Gesellsch.*, ii. 1884, i. p. 20.

in many plants, and later Terletzki[1] gave some details. The observations of these authors established the occurrence of protoplasm between the parenchyma cells in a small number of plants, but as I have stated this is not a rare phenomenon, but one of general occurrence, and I have found that the intercellular spaces of the true prosenchymatic tissues may also contain protoplasm.

I have investigated the plasma of the intercellular spaces in various collenchymatic, parenchymatic, and prosenchymatic tissues. For the investigation it is very important to use the reagents (absolute alcohol, picric acid, or osmic acid) very shortly before cutting the sections. Between the larenchyma cells, in the intercellular spaces protoplasm will always be found (bark and medullary parenchyma of the Loranthaceæ, Gingko, &c.). In longitudinal sections made of thick (2½ cm.) branches of Viscum the connection between the medullary parenchyma cells and the protoplasm filling t he intercellular spaces is also clearly to be seen. On the contrary, between the thin-walled cells which contain little protoplasm the intercellular plasm cannot, or in very rare instances, be detected (medulla of Phaseolus, Cucurbita, Sambucus, &c.). In the prosenchymatous tissues, *e.g.* in the bast-fibre of Viscum—after moderate swelling with sulphuric acid—the intercellular protoplasm, when stained with eosine, is clearly to be observed. The connection of this intercellular protoplasm with the protoplasts of the fibres is easily seen. We find intercellular protoplasm also in the xylem, *e.g.* in *Rhus cotinus*.

Most important is a fact which I have discovered in the course of my investigations, namely, the occurrence of inter-lamellar protoplasm. This was present very constantly in the leaves of mistletoe. The sections prepared with dilute sulphuric acid and stained, very exactly showed the fine plasmatic threads, corresponding in their disposition exactly to the middle lamella. This middle-lamellary "protoplasm" surrounded the protoplasts as a frame the picture, and ended in the protoplasm of the intercellular spaces. The threads are thicker at these points. The greatest precautions must be taken in the investigation of this middle-lamellary plasma: all very strong acids, &c., should be kept away from the prepared sections. When the cell-wall is very vigorously swelled the fine processes which bind the protoplasts together appear penetrating into the plasma-frame. This plasma-frame surrounds each cell, and in a section the framework of lamellæ occur in all planes and in all successive sections, and all the various constituent threads appear to intersect one another at all angles; it is consequently clear that the middle-lamellary plasm forms a *plasmatic mantle* round the protoplasts which is increased at each edge with the pillar-form (of three to four sides) intercellular plasm portions.

The intercellular plasm preserves its vitality, and in some instances we observe that some changes take place in the intercellular spaces. The intercellular plasm may be observed to cover itself with a special cell-wall; this membrane is the product of the intercellular plasm. This protoplasm can transform itself into a true new cell. In many cases in various tissues we have found this new mode of cell-formation, thus in the collenchymatous tissues (hypoderm of Liriodendron, Ficus, Sambucus, Solanum, Cucurbita, &c.), or in the xylem (*Rhus cotinus*), in the common parenchymatous bark (Viscum, Loranthus, &c.), in the medulla, &c. These newly formed cells grow very fast, and are only in their form and appearance different from the older cells. This cell-formation is very rapid, and it appears at first sight that the number of the tissue elements is by these "intercellular cells" (*Interstitial-celler* of J. G. Agardh,[2] who has observed this metamorphosis in the Florideæ), or "between-cells" (*Közti-sejtek* in Hungarian), considerably increased. A consequence of this great and fast growth is the formation of new "secondary" or "tertiary" intercellular spaces round the newly formed or transformed cells.

[1] *L. c.*, p. 169. [2] *Botaniska Notiser*, 1884, p. 130.

General Results.—I will now briefly conclude with a statement of the general results of my investigations upon the communication of the protoplasts, and upon the intercellular and middle-lamellary plasm.

(1) The protoplasts of all the tissues in united cells are in direct connection by means of finely attenuated protoplasmic threads.

(2) The connective threads traverse the pit-closing membrane (which is of a sieve-plate structure), while in unpitted cells they traverse directly the cell-wall. By these threads is the communication between the connective processes which occupy the pit-cavity from both sides directly established.[1]

(3) The intercellular plasm occurs not only in the intercellular spaces of the parenchymatic tissues, but also in those of true parenchymatic tissues.

(4) This intercellular plasm contains, in many cases, chlorophyll-granules[2] (Viscum).

(5) The intercellular plasm is in direct connection with the adjacent protoplasts.

(6) Corresponding to the middle lamella around the cells, we find a plasmatic frame; the sides of this frame end in the "intercellular" plasma. This plasmatic frame forms a veritable mantle round the protoplasts, and is increased at each edge by an intercellular plasm portion, which latter has a pillar form.

(7) The connective threads of the protoplasts traverse this "middle-lamellary" plasma; both are also connected.

(8) The probable origin of the intercellular plasma is this. During the cell-division, when the division was almost ended, little cytoplasmic portions become included in the young cell-wall, and it is also very probable that the connective threads, in many instances, are the remainder of the "nuclear connective threads," and that the middle-lamellary protoplasm is the remainder of the "cell-plate." All these plasma portions are by the thickened cell-wall much compressed together, and therefore only visible or distinctly visible by the swelling of the cell-wall.

(9) The intercellular plasm can cover itself with a cell-membrane, and in this way we find at the place of the intercellular spaces veritable new cells. About these new cells appears later new secondary or tertiary intercellular spaces.

(10) The protoplasm of the crystal-bearing cells (crystal glands) and that of the resin-cannel cells is also in communication with the adjacent cells.

The protoplasts of the plants (composed from tissues) form a higher unity, one synplast.

COLLECTING DESMIDS

IN his recently published "Desmids of the United States" the Rev. T. Wolle gives the following directions for collecting Desmids:—

The outfit need not consist of more than a nest of four or five tin cans (tomato or fruit), one within the other, for convenience of carriage, ten or twelve wide-mouthed vials, and a small ring-net made of fine muslin at the end of a rod about four feet in length. After selecting what seems to be a good locality, drag the net a few feet among the grasses and mosses, allow the bulk of the water to drain through the muslin, and then empty the residue into one of the cans; repeat this process as often as may be desirable. Ten or fifteen minutes after the cans have been filled most of the surface-water may be poured off, and the remainder transferred to a glass vial, where the solid contents will gradually sink, and the superfluous water can be again poured off, and the vessel

[1] Gardiner has also observed this fact in the plants investigated by him: for this reason we give this in the first place.

[2] J. G. Agardh has also observed endochrome granules in the intercellular spaces of the Florideæ. See *Botaniska Notiser*, 1884, p. 103.

filled up with deposits from other vials. In shallow places *Sphagnum*, *Utricularia*, *Myriophyllum*, or other finely cut-leaved water-plants should be lifted in the hand, and the water drained or squeezed from them into a tin can, to be subsequently treated in the same way. A few drops of carbolic acid in each vial, just enough to make its presence perceptible, will preserve the contents for months, and even years, from deterioration; the chlorophyll may fade, but this, in the case of Desmids, is of little importance; nevertheless, when practicable, always examine the materials when fresh. When dried on paper for the herbarium, the specimen can still, after being moistened with water, be examined under the microscope, but not with the best results, since the drying up is apt to collapse or otherwise distort the cells.

The collector will not know the value of his find until it has been brought, drop by drop, under the microscope; and out of the entire mass he may discern nothing to reward his labours. This, however, should not discourage him, as one or two failures are to be expected before meeting with an adequate reward. Sketches ought to be made, which should, of course, be very exact; and for this purpose the microscope should be provided with an eye-piece micrometer. It is so difficult to separate Desmids from their accompanying foreign matters, that it is seldom amateurs can mount them satisfactorily on slides; and this method of preserving specimens cannot therefore be recommended.

RELATIVE FREQUENCY OF STORMS IN THE NORTHERN HEMISPHERE[1]

THE portion of the northern hemisphere selected by the Signal Office of the United States for this discussion is necessarily that part for which the data required are available, and it may be considered as comprising a broad belt of from 30° to 40° of latitude in width, extending from the Pacific sea-board of America, through the United States, Canada, the Atlantic, and Europe, with the North of Africa, eastward into Western Siberia. It thus embraces some of the more important regions of the globe, including the great routes of commerce across the Atlantic. The thirteen charts, which show graphically the relative storm frequency for each month and for the year, have been constructed from data referring to 134 months in all, extending from 1863 to 1883. Of the storms which occurred in this extensive region from January 1876 to August 1881, the history of 2730 is briefly summarised. Of these 413 began and ended in America; 589 began in America and ended in the Atlantic; 190 began in America and crossed the Atlantic; 326 began and ended in the Atlantic; 655 began in the Atlantic and ended in Europe; 491 began and ended in Europe; and 66 began in America and crossed the Atlantic and Europe. The important bearing of these facts on the telegraphing from America of forecasts of storms about to strike the coasts of Europe scarcely needs to be referred to further than to remark how essential it is for the usefulness of such a service that it be placed in the hands of some competent and responsible central authority in the United States, as was suggested by us in 1879 (NATURE, vol. xx. p. 359), and which, we believe, has been carried out.

The chart for the year shows that the region where storms occur with greatest frequency is a long belt in America of about 200 miles in width, extending from the head waters of the Red River, about 95° W. long., eastwards through the Great Lakes to the mouth of the St. Lawrence, about 70° W. long. Surrounding this is a more extensive region where the number of storms, though not so large, is still a good way above the average; and again, surrounding this latter, is a still wider region, stretching from 105° W. long. eastward through the States and Canada, and through the Atlantic as far as 20° long. W. This is one of the most important regions of the globe as regards storms or cyclones. The excessive frequency of storms is probably due to a prevalence, during a large portion of the year, of the south-east trades, with a continuation of easterly and southerly winds into and through the Caribbean Sea and Gulf of Mexico, by which, from the superabundant vapour thus poured northward and eastward over the United States by upper and lower currents, frequent storms are originated.

Another region of considerable storm frequency extends from the south of Greenland, through Iceland and Farö, to the north of Sweden. Over this region it may be assumed that a more extended and exhaustive discussion of the storms occurring there than it has been possible to make, will reveal a greater frequency than is indicated on the chart, a supposition rendered highly probable by the frequent and extensive fluctuations of the barometer which occur in Iceland during at least three of the four seasons of the year. Of great interest is the less frequency of storms in the Spanish Peninsula and north-eastwards, through Central Europe, as far as Berlin; and the increased frequency to the southward over the northern half of the Mediterranean and the Black Sea, pointing to the important *rôle* played in the storms of that region by the evaporation from these seas.

This is substantially the distribution of frequency during the colder months of the year, when the larger number of storms occur. In the spring and summer months the distribution is materially altered. Thus, in April the regions of greater frequency extend further to southward in the United States and the Atlantic. It is in Europe, however, where this southing of the tracks of cyclones is most decidedly marked. At this season a broad patch is seen to overspread Ireland and England, and extend thence southward over the north of Spain, and then eastwards over nearly the whole of the south slope of Europe to near the Caspian Sea. As directly connected with the greater prevalence in spring of cyclones in Southern Europe are the east winds, which acquire at this same season their greatest virulence over the north-western part of the Continent. In summer, on the other hand, the coloured patches marking the regions of greater storm-frequency lie further to the northward than at any other season. Thus, in August, immediately to the north of 50° N. lat., there is an extensive region of greater storm-frequency, of about 900 miles in breadth, extending from about 45° W. long. to eastward as far as St. Petersburg. In this season the south of Europe is practically rainless, and storms are of extremely rare occurrence.

From the charts, the tracks usually taken by storms in different parts of the wide region under review cannot be ascertained, but can only be guessed at inferentially. It would be a great improvement if, in subsequent issues of the paper, these tracks were entered on the charts. This was done in 1882 in the "Physical Atlas of the Atlantic Ocean," prepared under the direction of Dr. Neumayer, of Hamburg. It was there shown from centres of the most frequent occurrence of low barometers, that to the west of the Mississippi is the region where most of the United States storms originate; that many of the Atlantic storms have their origin in the Gulf of St. Lawrence; and that the storms of North-Western Europe chiefly originate in mid-Atlantic and to the south-west of Iceland. The centres of low pressure also pointed to a retardation in the onward course of storms on advancing on large masses of land, as happens when storms approach the south of Greenland, the south of the British Islands, Denmark, and the Lofoten Isles. Of all storm-tracks approximately known in the northern hemisphere

[1] Charts of Relative Storm Frequency for a Portion of the Northern Hemisphere. Prepared, under the direction of General W. B. Hazen, Chief Signal Officer of the Army, by John P. Finley, Sergeant, Signal Corps, U.S.A. (Washington: Signal Office, 1884.)

the most frequently taken is that by the storms of the United States, which pursue an easterly course through the lakes to the Gulf of St. Lawrence. A considerable number advance from Nova Scotia to Davis Straits, but the greater number take a north-easterly course through the Atlantic towards Iceland and the North Cape. Among other tracks less frequently followed, but of great importance commercially and otherwise, are these: from New Orleans, along the east coast of the United States, towards Nova Scotia; from mid-Atlantic to the south of Ireland, and thence through Europe to the northern shore of the Mediterranean, and from the Atlantic about 42° lat. and 40° long., in a north-easterly course, quite outside, but at no great distance from, the British Isles, and thence towards the North Cape. Of the tracks more immediately influencing British weather, are one from Iceland in a south easterly direction through the North Sea and Germany, and three tracks starting from near Sicily, one eastward through the north of Germany, the second to the north-east to Christiania, and the third through Ireland and the Hebrides, these being the storm-tracks which chiefly give the British Islands their easterly and northerly winds. Gen. Hazen's charts suggest valuable hints as to the times of the year when these and other important routes are most frequently taken by storms.

THE U.S. FISH COMMISSION AT WOOD'S HOLL[1]

THE summer head-quarters of the United States Fish Commission is located at Wood's Holl, a village situated on the south side of Cape Cod, Mass., north of Martha's Vineyard. The coast scenery is pretty, and inland the country is undulating and partially clothed with forests of pines and other trees, which have mostly been planted within the last forty years. Wood's Holl and the neighbourhood is an increasingly favourite locality for the summer residences of the inhabitants of Boston, New Haven, New York, and other large towns in that part of the country, and already a colony of scientific men is making its appearance. Excursion steamers run frequently in the summer for the day trip from Newport and other places. As in the whole of that region of North America, the surface-soil is a thick deposit of glacial drift containing numerous boulders.

The site was selected on account of the purity of the water, owing to the absence of all fresh-water streams and presence of strong tidal currents which ensure a circulation of well-aërated water close to the shore, and also on account of the physical conditions which lead to a remarkable variety in the marine fauna being procurable within a short distance.

The warm current of the Gulf Stream, which sweeps up the eastern coast of the States, here becomes diverted by Cape Cod, and passes out into the Atlantic. This causes the pelagic fauna to be well represented, and were the local conditions of the coast more favourable it would cause the littoral fauna to be particularly rich. The cold currents from the north extend down the coast as far south as Cape Cod, which practically forms the southern limit of the Arctic littoral fauna. The narrow neck of the Cape thus separating two entirely distinct assemblages of animal forms. Lastly, the deep sea offers its peculiar fauna.

The site occupied by the Commission consists of a small spit of land, which was purchased by public subscription, and which has since been increased by reclamation.

At the present time the buildings of the Fish Commission are in a transition state. Formerly, the various officers had to severally obtain what accommodation they could in the village. Last August, however, the staff moved into the residence-house which has been built for that purpose. The residence-house is a red brick, gabled structure, with plenty of outside woodwork, a style of architecture which is very common in New England. On the ground-floor is a large central hall, into which open Prof. Baird's office, the sitting-room, dining-hall, reading-room, and other offices. A portion of the first floor is reserved for Prof. Baird and his family, the remainder is devoted to the bedrooms of the married officers who have brought their wives—families to the extent of one baby only are allowed! The bachelors' rooms are on the second floor. The whole building is most comfortably furnished. All the staff take their meals together with the ladies.

Hitherto the summer work of the naturalists has been carried on in two roughly-fitted barns. One serves mainly as a storehouse for the trawls, collecting implements, and jars and bottles for preserving specimens. Here also is the laboratory where the chemical investigations on the water obtained at various depths and from different localities are carried on.

The other building, which is on the wharf of the Lighthouse Board, is mainly devoted to the temporary storage of the zoological collections and to the work-tables of the naturalists, all the fixtures are of a very simple character, and call for no special mention. It is here that the material brought in by the steamers is finally sorted and, as far as possible, determined and catalogued; the material collected, however, affords more than enough occupation for the winter months.

A commodious new laboratory is being built close to the residence house, which is expected to meet all the requirements of this most important section of the Commission. It will be a plain three-storied brick building, in the basement of which will be large tanks. The ground-floor will be thrown open to the public as a general aquarium, in which will be tanks of various sizes for the illustration of the marine fauna and for the breeding of fish, much as in our ordinary aquaria. The first floor will be devoted to the laboratories of the working naturalists, to which of course the general public will not be admitted. The second floor will be divided between the physical and physiological laboratories, photographic room, and other work rooms.

Between this building and the residence-house is the pumping-station, by means of which fresh and salt water can be continuously circulated throughout either building.

On the sea-frontage several large open basins or tanks are nearly completed, in which fish-hatching will be carried on on an extensive scale. Cod-hatching is to be tried next season. The tanks are large enough to breed sharks, were they required. The water in these tanks rises and falls with the tide, owing to the porosity of the outer walls and the existence of small gratings; the latter are, however, under perfect control. Prof. Verrill has suggested that it would be desirable to have a kind of iron and glass cage or diving-box made, which, while open above, could be let down into the largest tank, and in which a person could observe and sketch the marine life around him under the most favourable conditions.

A long wharf has also been constructed for the use of the steamers of the Commission, and which also serves as a breakwater.

The general scheme of the buildings leaves little to be desired, and doubtless many improvements and additions will suggest themselves from time to time.

Not far from the Commission buildings is a plot of ground, which has been secured for the purpose of building a teaching and research laboratory, to be supported by those universities and colleges which do not possess any similar facilities of their own. This appears to be a very wise provision, and doubtless the Commissioner

[1] Originally spelt and still pronounced "Wood's Hole." The name was changed by order of the Postmaster General in 1875.

will afford every possible facility to those who may work them.

Not less complete are the arrangements for the collection of specimens and for the observations on depth, surface and bottom temperatures, and other physical features.

Two steamers have been built for the Fish Commission —the *Fish Hawk* in 1880, and the *Albatross* in 1883.

The *Fish Hawk*, a steamer of 484 tons of displacement and 205·71 tons measurement, was built particularly for use in the hatching of shad-eggs. Although unsuitable for long voyages or rough weather, she has proved a valuable boat for short trips and for dredging down to a depth of about 700 fathoms, having been well furnished with modern apparatus. Already much important work has been accomplished in the vessel in her subsidiary capacity, as is proved by the publications of the Fish Commission and Prof. Verrill's articles in *Science*, &c. (*Science*, vol. i. 1883, pp. 443, 531, and vol. ii. 1883, p. 153).

Last year the new steamer *Albatross* was specially constructed for deep-sea trawling. The extreme length of the vessel is 234 feet, the breadth of beam, moulded, is 27½ feet; the registered net tonnage is 400 tons, and the displacement, on a 12-foot draught, 1000 tons. She is most perfectly fitted with all those improvements in collecting and observing tackle which considerable experience has proved to be the best; but improvements and adaptations are continually being suggested. A full and illustrated account of the vessel is given by Mr. R. Rathbun in *Science*, vol. ii. 1883. pp. 6, 66. Suffice it now to mention that the comfort of the staff is as well provided for as their scientific necessities, and a complete system of electric lighting enables the laboratory work to be carried on at all hours. The main laboratory is 20 feet long, 26 feet wide, and 7 feet 10 inches high, and is situated amidships: above this is a well-lighted deck laboratory.

So far we have very briefly detailed the mere appliances for the collection and preservation of specimens. A short sketch of the mode of work might prove interesting.

The steamers are manned by naval officers and crew, a plan which serves the double purposes of lessening the expenses of the Commission and of spreading an interest in marine zoology throughout the navy. The officers have proved themselves to be most zealous in the work, and have cordially assisted the civilian staff in every possible manner; several important improvements in dredging and sounding apparatus have originated from some of them.

The sailors, too, take a personal interest in their occupation, and occasionally bring rare forms to the naturalists, which they have themselves caught in a hand-net.

Before an expedition, Prof. Baird consults with Prof. Verrill on desirable localities to explore, and instructions are given to the Commander, who also has charge of the mechanical portion of the dredging operations.

Mr. Benedict is the naturalist in charge of the vessel, and he is responsible for the specimens directly they arrive on deck; usually one or two naturalists work under his directions, the arrangement being that each is responsible for one or more groups of animals.

The contents of the trawl are subjected, immediately on their arrival on deck, to a process of sifting through a series of sieves of different sized meshes, and most of the animals are forthwith preserved. Numerous methods of conservation have been tried, but it is found that, under the special circumstances, alcohol is the best for general purposes. In some instances the jars have to be kept in ice to preserve the tissues whilst the alcohol is slowly penetrating; picric, chromic, osmic, and other acids and reagents, are used when deemed necessary. As a general rule, pelagic forms are killed by picric acid. All but the largest and smallest animals are put into glass-capped "butter-" and "fruit-jars," which are secured by a screw-down metal cap. Various devices are resorted to for large specimens; the smallest are placed in homœopathic vials.

Each dredging "station" has its serial number, and a full record of the position, depth, bottom and surface temperatures, with other details, is kept, and a label, bearing the number of its station, with certain other information, is put into each bottle of specimens. Mr. Benedict has a small hand-press on board, and he often prints such labels whilst the trawl is out. So far as opportunity presents, the species or groups are roughly sorted on board, and are then ready for identification in the laboratory. Excepting in the case of large quantities of common species, all the specimens from each haul are retained. Surface skimmings are similarly treated.

All the material so obtained passes through Prof. Verrill's hands, and he distributes certain groups to specialists to be worked out after he has described those forms which interest him. The zoological work of the Commission is so well known that it would be superfluous to even enumerate the naturalists on the staff.

After having been duly entered, the specimens, if properly named, are broken up into sets, of which the first naturally goes to the National Museum at Washington, the second to Prof. Verrill, the third to the Museum of Practical Zoology at Harvard University, Cambridge, Mass., and the remaining sets are variously distributed or kept in the stores as duplicates.

The Marine Laboratory is only officially open during the summer months. During the remainder of the year most of the officers are at Washington employing their time in identifying specimens, drawing up reports, and other routine work.

The biological portion of the work of the Commission is not merely restricted to the collection and identification of species; careful drawings are being made of every form collected, with a view to illustrating the entire fauna of that coast. The numerous papers of Prof. Verrill, Dr. Ryder, and others, prove that anatomical and embryological investigations are not neglected; life-histories are studied, and all possible data are collected on the influence of environment on organisms. It is intended, when the new building is completed, that the physiology of marine forms shall receive a due share of attention.

One object of the Commissioner is to thoroughly study the fauna of the American waters, fresh and salt, and encouragement and facilities are given to all the officers to follow their personal bent, of course paying a due regard to routine work. Naturally, at present, the officers are more engaged in the recording of species, since this pioneering work is the necessary precursor to morphological investigation; but the lines of the Commission are laid on too broad a scale to limit the original research of any officer.

ALFRED C. HADDON

ANCIENT AIR-BREATHERS

WHILE the records of the life of the sea have been preserved in abundance from early geological periods down to the present time, the chronicles of the living things of the land are comparatively scanty. The early history of land-animals has therefore a peculiar interest, heightened by the rarity of the evidence from which the history must be compiled. Considerable progress, however, has recently been made in this department of investigation. Within a few years, discoveries of the remains of scorpions and insects have successively been made in older and older strata, till now they have been disentombed almost simultaneously from older Palæozoic rocks in three different countries of the old world. Scorpions, which appear to be the most ancient type of air-breathing arachnids, have been found to be comparatively abundant in the lowest Carboniferous strata. The

first Palæozoic scorpion which came to light was described by Count Sternberg, in 1835, from a specimen obtained by him from the coal-formation of Chomle, near Radnitz, in Bohemia, which, in 1836, was named *Cyclopthalmus senior* by Corda.[1] Three years later Corda gave an account of another scorpion, from the same locality, under the name of *Microlabis*. From that time till 1866 these were the only Palæozoic scorpions known, but in the latter year Messrs. Meek and Worthen described two new genera from the Coal-measures of Mazon Creek, Morris Grundy County, Illinois, under the names of *Eoscorpius* and *Mazonia* respectively.[2] In 1873 Dr. Henry Woodward showed that scorpion remains, referable to the genus *Eoscorpius*, occur both in the Coal-measures of England and in the Carboniferous Limestone series of Scotland.[3] In 1881 the present writer had the privilege of studying and describing a large suite of scorpion remains belonging to the Geological Survey of Scotland, and obtained by their officers from the lowest Carboniferous rocks of the Scottish Border. The results were published in the *Transactions* of the Royal Society of Edinburgh, where several species belonging to the genus *Eoscorpius* were described and figured.[4] In that paper the following conclusion was announced:—"Although there seems to be sufficient reason to separate the genus (*Eoscorpius*) from any recent one, these ancient scorpions appear not to differ in any essential character from those now living. As far as the horny test, the only part now preserved to us, is concerned, they were as highly organised and specialised towards the beginning of the Carboniferous period as their descendants at the present day. It is unfortunate on that account that Messrs. Meek and Worthen should have chosen the name *Eoscorpius*, for the dawn of the scorpion family must have been at a much earlier period, and we may hope that their remains will yet turn up in the Devonian and Silurian plant-beds when these come to be thoroughly searched." The subsequent study of a much

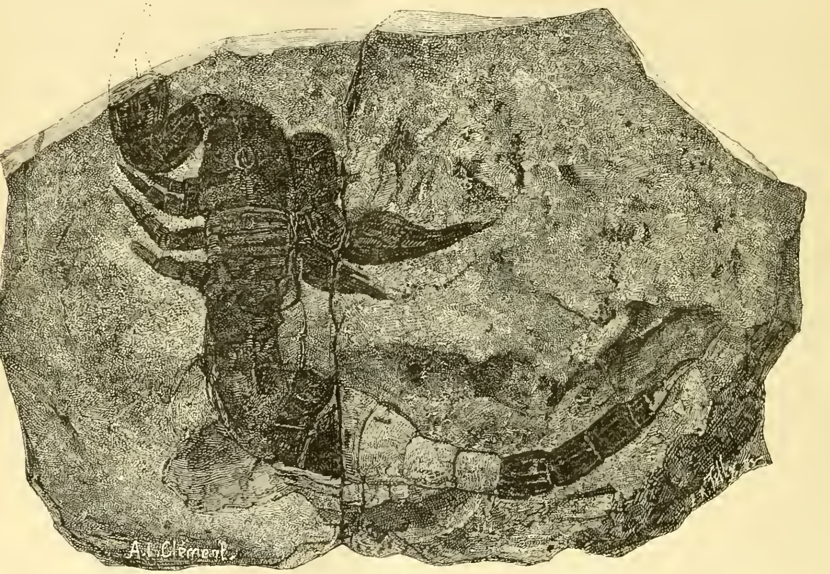


Fig. 1.—Fossil scorpion found in the Silurian rocks of the island of Gothland (Sweden). From the photograph sent by Prof. Lindström to M. Alph. Milne-Edwards (from *La Nature*).

finer collection from the same rocks has fully confirmed the conclusion as to the essential identity of structure between the living and the Palæozoic forms. The hope also expressed in the passage just cited has now been realised by the discovery of scorpions in the Upper Silurian beds of Scotland and Sweden, in the former by Dr. Hunter of Carluke, who obtained one from Lesmahagow in Lanarkshire in June 1883, and in the latter by Prof. Gustav Lindström, of the Swedish Academy of Sciences, Stockholm, who got his last summer (1884) from Wisby in the Swedish Island of Gothland. Prof. Lindström shows that his was a land animal and a true air-breather, and though of a more lowly type than the Carboniferous and recent scorpions, was yet to be placed among the members of that ancient family. Writing to M. Alphonse Milne-Edwards on November 24, 1884, he says:—

"The specimen is in sufficiently good preservation, and shows the chitinous brown or yellowish brown cuticle, very thin, compressed and corrugated by the pressure of the superposed layers. We can distinguish the cephalothorax, the abdomen, with seven dorsal laminæ, and the tail, consisting of six segments or rings, the last narrowing and sharpening into the venomous dart. The sculpture of the surface, consisting of tubercles and longitudinal keels, entirely corresponds with that of recent scorpions. One of the stigmata on the right is visible, and clearly demonstrates that it must have belonged to

[1] Corda, in *Böhmischen Verhandlungen*, 1836, and Wiegmann's *Archiv*, 1836. vol. ii. p. 360. Figured in the *Transactions* of the Bohemian Museum.

[2] *American Journal of Science*, 2nd series, vol. xlv. p. 25. "Geological Survey of Illinois," vol. iii. pp. 563-565.

[3] *Quart. Journ. Geol. Soc.*, vol. xxxii. p. 57.

[4] *Transactions* of the Royal Society of Edinburgh, vol. xxx. pp. 397-412, Plates XXII., XXIII.

an air-breathing animal, and the whole organisation indicates that it lived an dry land. In this scorpion, then, which we have named the *Palæophoneus nuncius*, we see the most ancient of land-animals. In the conformation of this scorpion there is one feature of great importance, namely, four pairs of thoracic feet, large and pointed, resembling the feet of the embryos of several other tracheates and animals like the Campodea. This form of feet no longer exists in the fossil scorpions of the Carboniferous formation, the appendices belonging to which resemble those found in the scorpions of our own day."

To Prof. Lindström is thus due the honour of first announcing the discovery, and it was not till Dr. Hunter had received a photograph of the Swedish specimen, together with a preliminary notice of his find from Prof. Lindström, that he became fully aware of the importance of his own discovery. On receipt of the photograph and the notice, Dr. Hunter showed the Scottish specimen to the present writer (December 1884), with whom he has agreed to describe the geological and zoological aspects of the find.[1] In the meantime, a short preliminary description for comparison with the Swedish animal may not be out of place here. The rocks from which the Scottish example was obtained are the well-known Upper Silurian beds of Dunside, Logan Water, Lesmahagow, Lanarkshire, which have yielded such a magnificent suite of Eurypterids, and supplied a great part of the materials for Dr. Henry Woodward's work on the Merosomata. The animal in this specimen is about an inch and a half long, and lies on its back on the stone. Its exposed ventral surface shows almost every external organ that can be seen in that position, and in this way serves to supplement the evidence supplied by the Swedish specimen. As in the northern individual, the first and second pair of appendages of the cephalo-thorax in the Scottish example are chelate, but the palpi are not quite so robust. The walking-limbs, though not so dumpy as in *P. nuncius*, also terminate each in a single claw-like spike. The arrangement of the sternum shows a large pentagonal plate (metasternite), against which the wedge-shaped coxæ of the fourth pair of walking-limbs abut. The coxæ of the third pair bound the pentagonal plate along its upper margins, and meet in the mid-line of the body, where they are firmly united. The coxæ of the first two pairs, as well as the bases of the palpi, are drawn aside from the centre line of the body, showing that, as in recent scorpions, these alone were concerned in manducation, or rather the squeezing out of the juices of the prey. From the circumstance of these being drawn aside, the medial eyes are seen pressed up through the cuticle of the gullet, and a fleshy labrum (camerostome) appears between the bases of the chelicerae.

Behind the pentagonal plate and the coxæ of the hindmost limbs there succeeds a space shaped like an inverted V, where the test is thin and wrinkled in the line of the long axis of the body. It is just along this line that the trunk or abdomen most easily separates from the cephalo-thorax in recent scorpions, and it is at once apparent that the trunk in this case is as far separated from the cephalo-thorax as it can well be without being detached. Similar longitudinally-wrinkled skin is seen to unite the dorsal and ventral scutes up the whole right side of the trunk. At the interior angle of the inverted V there hangs downwards a narrow bifid operculum flanked on each side by the combs, which have each a broad triangular rachis set along its lower edge with the usual tooth-like filaments. The combs almost hide the first of the four ventral sclerites, which bear the breathing apparatus in recent scorpions, notwithstanding which all four of these exhibit on their right side undoubted slit-like stigmata at the usual places. The fifth ventral scute of the trunk suddenly contracts posteriorly, and to its narrow end is articulated a long tail of five joints and a poison-gland with a sting. These joints are all constructed on the same principle as those of recent scorpions, and as the articular surfaces are more highly facetted on the dorsal than on the ventral aspect (a portion of the tail of the specimen lying sideways allowing of these observations), there can be no doubt that the animal was in the habit of carrying the tail over the head (so to speak) and stinging in the same manner as its recent congeners.

The above characters are shown in the accompanying woodcut (Fig. 2) on nearly the same scale as that of the figure of the Swedish example, viz. about twice the natural size, taken from a drawing made by the writer. From it and the description it becomes apparent that the animal was a true air-breather and a land-animal.

The presence of the remains of these ancient murderers

FIG. 2.—Fossil scorpion from the Upper Silurian rocks of Lesmahagow, Lanarkshire, Scotland, found by Dr. Hunter, Carluke; magnified two diameters.

in such old strata necessarily suggests the question, What was the nature of their victims? As far as the Carboniferous scorpions are concerned, we are acquainted with several other arachnids, numerous hexapod insects, and chilognathous myriapods, which might have formed their prey. The Middle Devonian rocks of Canada have furnished remains of dragon-flies, which were known as the oldest land animals until the present writer showed, in 1882, that chilognathous myriapods were far from uncommon in the Lower Old Red Sandstone of Forfarshire in Scotland,[1] and the *Gyrichnites* of the Lower Devonian of Gaspé are doubtless the casts of such animals.[2] It is but a short step from the Lower Old Red Sandstone of Scotland to the Upper Silurian. The lowest part of the Lower Old Red Sandstone, which is a lake-formation, may be represented elsewhere by marine strata, which would undoubtedly be called Upper Silurian, and, in fact, high up in the Lower Old Red Sandstone of Lanarkshire, which contains *Cephalaspis*, a band of shale occurs,

[1] It has been erroneously stated in the *Annals and Magazine of Natural History*, p. 76, and elsewhere, that the specimen was sent to me in 1883. The above statement is the correct one.—BEN. N. PEACH.

[1] *Transactions* of the Royal Physical Society, 1882, vol. vii. pp. 177-188, Pl. II.

[2] *Transactions* of the Royal Society of Canada, vol. i. Pls. xi., xii.

which proves that marine conditions recurred for a short time, and brought again into the lake basin such marine Silurian forms as *Beyrichia*, *Orthoceras*, and even *Graptolites*.[1] We are not left to conjecture the nature of Silurian insect-life, for Mr. Charles Brongniart intimated to the Paris Academy of Sciences (December 29, 1884), through M. Alphonse Milne-Edwards, the discovery of a fossil insect, the rock containing which is the Silurian sandstone of Calvados, and which is even more ancient than the strata containing the Swedish and Scottish scorpions. The specimen consists of the wing, the characteristics of which are those of the wings of Blatta.

It may be that, as recent scorpions feed extensively on the eggs of various Invertebrates, the Silurian species also visited the shores for the eggs of animals left bare by the tides, among which *Parka decipiens*, the eggs of its marine allies, the Eurypterids (if the latter had the habits of their near relation, the recent king-crab), would form a *bonne bouche*. If this suggestion should prove to be well founded, we may suppose that it was this habit of frequenting the shores that led the present specimens to be imbedded in marine strata, as from their completeness they could not have been borne far from their native shores.

BEN. N. PEACH

[1] A. Geikie. "Explanation of Sheet 23 of Geological Survey of Scotland," 1873, p. 14.

NOTES

WE greatly regret to record the death of Dr. J. Gwyn Jeffreys, F.R.S., from a sudden attack of apoplexy, on Saturday last, at the age of seventy-six years. We hope to refer at length, in our next number, to Dr. Jeffreys's scientific work.

SIR WILLIAM THOMSON will on Monday give an address at the opening of the fine laboratories at University College, Bangor. In the evening there will be a *conversazione*.

THE premium of the Society of Telegraph Engineers and of Electricians was presented, at the annual meeting, to Prof. George Forbes, F.R.S.E., for his paper on "The relation which should subsist between the strength of an electric current and the diameter of conductors to prevent over-heating." The Fahie premium was presented to Mr. W. H. Stone, M.A., for his paper on "The physiological bearing of electricity on health." The Paris Electrical Exhibition premium was presented to Mr. H. C. Mance for his paper on "A method of eliminating the effects of polarisation and earth-currents from earth-tests." Having presented the premiums and thanked the members for their support during his year of office, Prof. Adams vacated the chair and introduced the president for 1885, Mr. C. E. Spagnoletti.

AT the recent meeting of the Government Grant Committee, Prof. Ewing, of Dundee, received a grant of 100*l*. to institute observations of earth movements on Ben Nevis. He was asked to undertake this work by the Directors of the Observatory there, and he intends to look both for minute earth tremors, such as have been observed by Rossi and Bertelli in Italy, and for slow movements of the horizon, such as those observed by Messrs. G. H. and H. Darwin at Cambridge. The isolated position of the Ben Nevis Observatory makes it particularly well suited for observations of this kind.

SIR JOSEPH LISTER, Professor of Clinical Surgery in King's College, London, has been appointed by the German Emperor a Knight of the Order Pour le Mérite for Science and Arts.

WE have received from the Fine Art Society a "remark" proof of a very fine etching, by Mr. Flameng, of Mr. Collier's portrait of Prof. Huxley, which attracted so much attention at the Royal Academy Exhibition two years ago. Doubtless many of our readers will remember the leading features of the portrait, the etching of which will form a suitable companion to that of Mr. Darwin by the same engraver, also from a painting by Mr. Collier.

THE first arrangement for supplying private houses with electricity is now in working order in Paris. It has been placed in the Passage des Panoramas, Galerie Vivienne, for the use of all the houses in this extensive block. The motor being a gas-engine, the use of which is legal in cities, the proprietors of this lighting establishment have nothing to do with civic authorities and regulations. Six or seven shops are now lighted by about 100 Woodhouse and Rawson incandescent lamps.

THE Russian Government are preparing an expedition to Western Siberia, for the purpose of examining some sulphur deposits recently discovered there. The natives have for many years had knowledge of these deposits, but the Government have only recently been made cognisant thereof, through a report by Lieut. Kalityn. According to the statement of M. Konschin, a mining engineer, one of the deposits contains upwards of five million pood of sulphur, the number of the former being ten. Europe has hitherto been supplied with this article from Sicily, and it is hoped that the Russian deposits may compete with the mines in that island. In Russia sulphur has hitherto only been found at Tchirkota, not far from Petroffsk, in Daghestan, which has chiefly been delivered to the powder-mills. The expedition in question will leave St. Petersburg next month.

MR. H. CECIL writes to us with reference to our note on the British Museum lectures last week. "To some of us," Mr. Cecil writes, "it is a source of no little astonishment that the materials of these lectures, some of them of such surpassing interest, should not be made accessible to students and the general public in some full, substantial, and permanent form. Besides, it would surely pay. The hunger of men never was keener for every single seed-corn of threshed-out verity; and I am myself constantly asked with reference to the subjects of these very lectures: Where can I find this in accurate form, vouched by the writer's name, and open to the examination and judgment of all men?"

A MICHIGAN paper gives an account of a phenomenon that was witnessed in Orion and vicinity on the evening of December 20:—At Marshall a bright luminous ball of large dimensions, tinged with a deep green, apparently lit up the whole heavens. The light was instantly followed by a loud noise, somewhat resembling distant thunder, which continued for about one minute. The general opinion is that it was an aerolite. At Jackson the vibration was preceded by a vivid flash in the heavens, resembling lightning. The phenomena were noticed in several portions of the city. To the south it was felt quite strong. Near Hanover and Horton the quaking of the earth was observed, while the heavens for an instant were lighted by an instantaneous flash, followed by a loud report. Buildings were slightly jarred, and the people noted the motion of their houses.

THE Rev. H. Sumangala, High Priest of Adam's Peak, Ceylon, has recently contributed to the *Orientalist*, a magazine published at Kandy, a short summary of the views of Hindu astronomers on the form and attraction of the earth. The theory of Bhāskara, who flourished in the twelfth century of our era, was that the terrestrial globe, which is composed of earth, air, water, space, and fire, is of a spherical shape, and being surrounded by planets, such as the Moon, Mercury, Venus, the Sun, Mars, Jupiter, and Saturn, and by the orbits of stars, stands firm in the midst of space by its own power, without any other aid. This, he says, is a well-ascertained fact. Like the pollen in the Kadamba flower, on its surface are countries, mountains, gardens, and buildings, where Rākṣasas, men, Devas, and Asuras dwell. He refutes the theory that the earth cannot stand of itself without any support by arguing that, if there be

a material support to the earth, there must be another upholder of that, and again another of this, and so on; then there will be no limit, and if, ultimately, self-support must be assumed, why not assume it in the first instance? Is not the earth one of the forms of Siva? As by nature heat is in the sun and fire, coldness in the moon, fluidity in water, hardness in stone, so mobility is in the air, and immobility in the earth. Each object has its own faculty, and "wonderful indeed are the faculties implanted in objects." As to the attraction of the earth, Bhāskara observes that the earth, possessing an attractive force, draws towards itself any heavy substance situated in the surrounding atmosphere, and that substance appears as if it falls. But whither, he asks, can the earth fall in ethereal space, which is equal and alike on every side? He ridicules the Buddhists for holding that the earth descends in unbounded space. An astronomical work anterior to Bhāskara's time says the terrestrial globe possesses Brahma's most excellent power of steadiness, and remains in space. The succession of day and night is said to be caused by the rising and setting of stars, the planet, and the zodiac. Arya Bhatta, in the sixth century, maintained the existence of a diurnal rotation of the earth round its own axis. The sphere of the stars, he states, is stationary, and the earth itself, making a revolution, produces the daily rising and setting of stars and planets.

Mr. Hoffmann, of Washington, has addressed a letter to the Anthropological Society of Paris, stating that in various ancient burial places in Southern California, and in the islands of Santa Cruz, Santa Rosa, and San Miguel, he has found instruments which he believes to be those employed in tattooing. The natives here do not tattoo themselves now, with the exception of the Haida Indians of Queen Charlotte's Island; they only paint their faces, but still many individuals bear traces of tattooing. Mr. Hoffmann found vessels containing red ochre and cakes of a black substance, composed apparently of the hydro-oxide of manganese, as well as some very sharp needles of bone, wood, and the fins of fish. These needles are still preferred, by tribes which practise tattooing, to those of steel, which they could procure easily.

The publications of the Russian Geological Commission succeed one another rapidly, each of them containing some important contribution to the geology of Russia. The third fasciculus of its *Memoirs*, just published, contains a monograph by M. Tschernyschen, on the Devonian deposits of Russia. The interest awakened by the recent explorations in the Ural Mountains, where deposits quite analogous to those of the Hartz and the Eifel have been discovered, induced the author to describe some of the old collections of the Palæontological Museum at the Mining Institute at St. Petersburg, namely, that of Meglitzky and Antonoff, from the shores of Lake Kotluban, in the Southern Ural. These fossils proved to be Upper Devonian, and many of them quite new for the Ural region; they also enabled the author to give the following scheme of the Devonian deposits of the Ural mountains:—The Lower Devonian is represented by schists and sandstones, with numerous remains of *Atrypa hatilingius*, Schmer, and by the limestones of Nyaze-Petrovsk and Yurezan (upper part of the Lower Devonian), which are akin to the Greifenstein limestones and the Wissenbacher schists of Germany. The Middle Devonian consists of sandy limestones and unfossiliferous marls, which appear on the Ay and Yurezan rivers from beneath dolomites. The rich fauna of the former corresponds to that of the Eifel. And, finally, the Upper Devonian is represented by the limestones of Lake Kotluban, of Murzataeva, River Vilva, the mouth of Sulema, &c.; it corresponds to the Cuboides and Goniatites schists of the Eifel and Hartz, and is covered by the Clymenia limestones of Verkhneuralsk, which appear, in the Hartz, above the so-called *Intumenscens-stufe*. Comparing further the Devonian deposits of the Ural with those of the Petchora, as described by Keyserling, of the Government of Orel, according to his own observations, and of North-Western Russia, the author arrives at the following interesting conclusions:—On the Petchora we have Lower Devonian deposits of the Vol and Ukhta rivers, akin to the Middle Devonian of the Ural and Western Europe; and an upper layer (on the Middle and Lower Ukhta) which corresponds to the Goniatite schists of the Ural and the *Goniatites intumescens* deposits of the Rhine. The Middle Devonian of the Ural and Petchora correspond to the dolomitic limestones of Livonia and to the lower deposits of the south-east, which are rich in corals and tentaculites. For several interesting details we must refer, however, to the paper itself, which is followed by a *résumé* in German (twenty-four quarto pages), and is accompanied by three plates representing Devonian fossils.

The geological map of Russia, prepared by the Geological Commission, is well advanced, and during this year we expect the appearance of three sheets including a part of the Ural Mountains, the government of Kostroma, and the Volga-and-Don region. As to the last issue of the *Izvestia* of the Commission, we notice in it a paper by M. Mikhalsky on the structure of the Kielce Mountains and the surrounding region. Its chief features were already known from the explorations of Pusch and Rœmer, but the very age of the deposits of this region (Devonian, Trias, Jura, and Chalk) had to be determined with more precision. The Trias reaches a great development, and M. Mikhalsky confirms Prof. Rœmer's affirmation that all three chief subdivisions of the German Trias are found in Poland. The Jurassic formation is also represented by three different deposits: one of them closely corresponds to the Jurassic deposits of Southern Germany, namely, to those of Bavaria, as already indicated by Ludwig Ammon. Another, which contains the *Exogyra virgula*, together with *Gryphæa dilatata* and *Pecten inæquicostatus*, seems to be an intermediate deposit between the Oxfordian and Kimmeridge deposits of England. As to the Oolite, its fossils are more like those of France and Middle Germany, but substantially differ from those of South Germany. A series of Jurassic deposits at the Peklo village is interesting, as it affords a remarkable mixture of the Upper Jurassic fauna of Middle Europe with the Jurassic fauna of Russia. It contains the ammonite *Perisphinctes virgatus*, which has been found only in the Russian Jurassic formation. As to the Chalk, it is represented in the south-west by much dislocated deposits containing *Inoceramus Crispii* and *I. striatus*, both characteristic of the Senonian subdivision. The whole is covered with thick deposits of Boulder Clay, containing Scandinavian and local boulders; one boulder of granite has been observed on the summit of the northern chain of the Kielce ridges, and, judging from the general character of the glacial deposits, the author believes in the extension of the Scandinavian ice-sheet as far as the Kielce ridge.

Science states that the U.S. Bureau of Navigation of the Navy Department reports that 145 compasses with the four-needle card have been issued to ships during the past year, and that they have given general satisfaction, the behaviour of the improved compasses used by the Greeley relief expedition in high latitudes being especially commended. This expedition gathered considerable data concerning the variation of the compass in high latitudes, but, owing to its speedy return, none were obtained concerning the magnetic force and dip. The data concerning compass variations, collected by the Department during the past year, are in course of preparation for publication. Professional paper No. 17, entitled the "Magnetism of Iron and Steel Ships," is in the press; and No. 18, on "Deviations of the Compass in U S. Naval Vessels," is nearly ready. Preparations have been made for a careful examination of the magnetic character of the new steel vessels, and a compass station is to be

established in Narragansett Bay. The instruments for a compass testing-house are now in the possession of the Bureau, and a building will be erected when the appropriation is made. In view of the probable necessity of compensating the compasses of these new vessels, a binnacle has been designed in the Bureau for this purpose, and it will be placed in the *Dolphin* to be tested.

IN accordance with a recommendation of the recent Geodetic Conference, we learn from *Science* a series of observations for latitude is to be made at the U.S. Naval Observatory, which, taken in connection with a similar series made elsewhere, and compared with observations made after an interval of some years, will assist in determining whether there are any slow changes taking place in latitudes upon the earth. Lisbon, which is very near the same parallel as Washington, is expected to co-operate with the Naval Observatory. The observations will be made with the prime vertical instrument; and at Washington a line officer of the navy will be detailed for the work, which will probably require several years.

AT University College, London, Dr. J. A. Fleming will commence a course of lectures and demonstrations on Modern Applications of Electricity in the Arts, on Friday, February 6, at 4 p.m. The first lecture will be open to the public without payment or tickets.

THE *Revue Scientifique* now publishes a weekly supplement containing reports of the proceedings of the Paris scientific societies; this supplement may be obtained separately.

THE additions to the Zoological Society's Gardens during the past week include a Moose (*Alces machlis*) from Russia, presented by Mr. Evelyn Hubbard; a Goshawk (*Astur palumbarius*), British, presented by Mr. W. H. St. Quintin, F.Z.S.; a Pink-footed Goose (*Anser brachyrhynchus*), British, presented by Major W. H. Fielden, C.M.Z.S.; two Yaks (*Poephagus grunniens*) from Tibet, six Dunlins (*Tringa alpina*), British, purchased.

GEOGRAPHICAL NOTES

AT the meeting of the Paris Geographical Society on the 9th inst. M. Maunoir read a paper on the explorations of Capt. Aymonier in Indo-China in 1883 and 1884, during which he collected many epigraphical documents and notes on Northern Laos and the basin of the Mouna. On December 10 the traveller was to leave Saigon for Binh-Thuan, in the extreme south of Annam, to study the monuments left behind by the Cham. It is wholly new ground. A letter was read from the French Consul at Zanzibar giving the latest geographical news from Eastern Africa. M. Deloncle summarised his recent exploration in Malacca. M. Paul Fauque, who is charged by the Ministry of Education with a scientific mission to Sumatra, described the results of his journey, and gave more details on the character, manners, and customs of the natives of the Siak country and of the Kingdom of Acheen. He added much valuable information on the geography, natural history, and mineralogy of this great island. His collections are to be distributed amongst various museums in France. The following medals were awarded:—A gold medal to M. de Foucauld for his journey in South Morocco and his exploration of the southern extremity of the Atlas Mountains; a gold medal to Dr. Neis for four journeys in Indo-China and in the hitherto unexplored parts of Laos; the La Roquette prize to the Danish summary of geological and geographical enterprises in Greenland (*Meddelelser om Grœnland*); the Jernard prize to M. Leroux, the publisher, for the volume of documents on the history of geography from the thirteenth to the sixteenth century; and the Echard prize to M. Dumas Vorzet for maps and cartographical labours. M. Allain referred to the defectiveness of geographical education in some public educational establishments, and advised that all the State libraries in Paris should be provided with as complete a collection as possible of geographical works.

THE editor of *Petermann's Mittheilungen* has issued a circular with the January number of his journal, giving notice that in future the monthly parts will consist of three main sections: (1) Original papers, as heretofore; (2) a monthly report of the advances of geographical discovery and colonisation in countries outside Europe; (3) a literary section referring to recent geographical and cartographical works, with the exception of pure travels, which will be dealt with in the second section. The valuable supplementary parts (*Ergänzungsheften*) will be continued as before.

THE report has been published of a journey by four French officers among the Muongs of the Black River, which enters the Red River of Tonquin a little below Sontay. These tribes are described as more civilised than the Moïs of Cochin China; they are practically independent, although the Annamites profess to appoint their chiefs; they are very warlike, intelligent, and industrious, making their own arms, which are sometimes very beautiful. After having acquired all the information they could as to Muong silk and silk manufactures, the travellers explored the mountainous regions among the district. There are gold mines in the hills worked by Chinese, but at some of them they have armed themselves in great numbers since the recent troubles, and will allow no one, French or Muong, to approach them. The members of the expedition, however, saw enough to convince them that the district is rich in minerals, especially gold.

THE Argentine expedition to the Chaco will, it is stated, have the result of adding a large territory to civilisation and agriculture. This forms for the most part the basin of the Rio Bermejo, or Red River, which flows down from the Andes, and commences to be of importance towards the 61st degree of longitude. Soon after it receives the waters of the Tenco, and should be navigable unless its bed is obstructed by the trunks of trees and if it does not traverse lagoons where its channel will be difficult to find. It flows in a south-westerly direction, and enters the Rio Paraguay after a course of about 500 kilometres. The districts through which it flows are well-wooded; they are inhabited by tribes of Indians, whose favourite weapon is the arrow, and who, when they do not live by hunting and fishing, exist on the locusts which abound and on the cattle which they can contrive to steal from the Argentines. The number of inhabitants of this part of the Chaco is estimated at 10,000.

Globus publishes a letter from Dr. Claus, a member of the Steinen expedition into one of the most unexplored parts of Brazil. It was for some time doubtful whether the expedition was examining the Xingu, or some other neighbouring tributary of the Amazon. It appears now that the Xingu was the river explored. On May 26, 1884, the expedition left Cuyabá, the capital of the Brazilian province, Matto Grosso, arrived on July 20 at Rio Batovy, and in the end of October at Pará, at the mouth of the Amazon. Dr. Claus writes that they completely carried out their programme. After a journey of two months from Cuyabá, they sailed in canoes down a small river, which, according to the maps, should belong to the Xingu region. The districts around the source of this river are inhabited by numerous tribes who have never met with white men, and who use only implements of stone and bone. At the 12th parallel they came on the Xingu. The cataracts caused the travellers the utmost difficulty, and they also suffered much from hunger. For a whole month they had nothing but beans to eat. During part of the descent of the Xingu, also, they met with the same troubles and privations; but towards the end of their journey they fared much better, passing along from one Indian village to another. On October 15 they arrived at the first Brazilian settlement on the 4th parallel. The head of the expedition has a large collection of Indian objects, and the collections of the others, though much damaged by water, are otherwise safe.

MR. WM. CAMERON, F.G.S., an indefatigable explorer of Malayan countries, has just prepared, at Singapore, a large and elaborate map, on a scale of half an inch to the mile, of districts recently explored by him in Selangor, Ulu Selangor, Sungei Ujong, and other parts of the Malay Peninsula. The map is said to be excellently drawn up, and to be a valuable acquisition to our existing geographical knowledge of the Malay Peninsula, which is somewhat limited.

A GEOGRAPHICAL conference is about to be held in Melbourne on the occasion of the first annual meeting of the Victorian branch of the Geographical Society of Australia. Members of the general council of the Society, as well as of the local councils

of the New South Wales and Victorian branches, are invited. Among the subjects to be discussed are the necessity of defining the exact meaning of the geographical term Australasia, the compilation of a reliable work on the geography of Australia for Australian schools, the exploration of New Guinea, and the discovering and defining of the exact boundaries of what may now be termed British New Guinea.

ASTRONOMICAL PHENOMENA FOR THE WEEK

1885, February 1–7

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 1

Sun rises, 7h. 40m.; souths, 12h. 13m. 53·2s.; sets, 16h. 47m.; decl. on meridian, 16° 58′ S.: Sidereal Time at Sunset, 1h. 35m.

Moon (2 days past Full) rises, 18h. 22m.*; souths, 1h. 23m.; sets, 8h. 12m.; decl. on meridian, 8° 21′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on Meridian ° ′
Mercury	6 31	10 33	14 35	22 3 S.
Venus	6 37	10 39	14 41	22 3 S.
Mars	7 52	12 24	16 56	17 21 S.
Jupiter	18 34*	1 37	8 40	11 28 N.
Saturn	12 14	20 17	4 20*	21 32 N.

* Indicates that the rising is that of the preceding, and the setting that of the following nominal day.

Occultations of Stars by the Moon

Feb.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to left ° °
1	B.A.C. 3529	6	4 16	5 20	90 292
1	*d* Leonis	5	20 1	20 57	31 218
2	B.A.C. 3836	6	3 29	4 41	76 276
2	75 Leonis	5½	5 26	6 28	116 267
2	76 Leonis	6	6 29	7 25	81 312
5	B.A.C. 4591	6	3 13	4 11	95 199

Phenomena of Jupiter's Satellites

Feb.	h. m.		Feb.	h. m.	
1	5 46	I. tr. ing.	3	23 41	I. occ. reap.
2	2 33	I. ecl. disap.	4	0 9	II. ecl. disap.
	5 15	I. occ. reap.		3 49	II. occ. reap.
	6 6	II. tr. ing.		18 38	I. tr. ing.
	22 8	IV. ecl. disap.		20 57	I. tr. egr.
3	0 12	I. tr. ing.	5	19 13	II. tr. ing.
	2 31	I. tr. egr.		22 8	II. tr. egr.
	6 25	IV. occ. reap.	6	2 37	III. tr. ing.
	21 1	I. ecl. disap.		6 13	III. tr. egr.

Saturn, February 1.—Outer major axis of outer ring = 44″·5; outer minor axis of outer ring = 20″·1; southern surface visible.

February 1, 7h.—Jupiter in conjunction with and 4° 9′ north of the Moon.

SCIENCE IN VICTORIA

The President of the Royal Society of Victoria devoted a considerable portion of the presidential address contained in the last published volume of the Society's *Transactions* to a review of the progress of science in the colony. It might at first sight be supposed that, in young communities like those of the Western States of America or of our own Australasian colonies, the struggle to develop their resources to the utmost, which occupies every one, and the total absence of a leisured class, would be an insurmountable obstacle to scientific work, or indeed to work of any kind for its own sake. But the numerous and valuable publications which we constantly receive from scientific societies formed among young English-speaking communities all over the globe—in Japan, China, the Straits, Ceylon, Australia, Canada, the United States, the Cape, and many other places—show that this impression is wholly incorrect, and that the members carry with them into scientific work the energy and perseverance which they exercise in their ordinary avocations.

The first sign of progress which Mr. Ellery had to chronicle in his address was that the Royal Society had grown too large for its building, and consequently the more spacious rooms of the Melbourne Athenæum had to be selected for the annual address. The number of members has increased annually, and the financial condition of the Society is satisfactory. During the year under review there has been "a vigorous and healthy progress," but the young body, having outgrown its juvenile garments, must provide itself with more capacious ones in the shape of considerable additions to the Royal Society house. In the several national scientific and technical departments the year has been one of active labour, and their progress, in common with that of the Society, has been considerable. There is, the President reports, an undoubted and general increase in the desire for knowledge in the various pure and applied sciences, and especially as applied to technical training and to the daily requirements of life. New societies for the prosecution of study and research, more especially in the natural sciences, have come into existence in the provinces, and the older societies and schools are increasing in their influence and usefulness. The School of Technology and the technological museums at Melbourne are growing rapidly. An example of the great economic benefits of such institutions was afforded during the year under review by the opening of a new trade between Victoria and India wholly on account of the knowledge derived in Melbourne from the museum collection of Indian woods, and it is anticipated that a like result will accrue from a collection of colonial economic woods sent to Calcutta. In Ballarat and Sandhurst the schools of mines are important centres of teaching in the arts and in applied and natural sciences. In Melbourne itself the Medical and Pharmaceutical Societies, the Microscopical Society, and especially the Field Naturalists' Club, have partaken in the general progress.

The President then comes to the question of what has actually been done in Victoria during the year towards the advance of natural science. The first person referred to in this connection is Baron Mueller, to whose research is due a large proportion of what is known of Australian botany. He succeeded in getting the Colonial Government to purchase for the Botanical Museum the collection of Dr. Sanders of Hamburg, a leading authority on algæ, and on European and North African botany. Valuable additions, illustrative of the flora of the western coast districts of Australia, were made to the same museum, which has really been formed by Baron Mueller himself from his collections, extending over nearly forty-four years. Among new publications of the year were additions to the "Fragmenta Phytographia Australis," a continuation of the "Systematic Atlas of the Eucalypti," a new edition of a work on "Select Plants for Industrial Culture," and "A Systematic Census of Australian Plants." A second volume of the vegetable fossils of the auriferous drifts was completed, and in its pages are described and compared most of the fossil fruits of the Pliocene period. A vast field of investigation still remains in the fossil foliage of the Miocene deposits. With a reference to the work of the Melbourne Observatory during the year the president closes that portion of the address with which we are specially concerned here. At the end of the address he argues that the Royal Society is broad enough in its constitution to embrace all sciences, and that, therefore, various sections in connection with it should be formed rather than new societies for each science. The community is not, he thinks, yet large enough to maintain, in an effective state, a number of scientific societies; and if all in Victoria interested in the progress of science, or engaged in her various byways, were to unite together, not only would more useful work be done, but the work would be more valuable, on account of being subjected to a wider criticism. All the colonial scientific societies combined would form a strong body, capable of fostering and even subsidising scientific research. In one respect, perhaps, the wheels of the Society might run more smoothly. The volume (a rather small one) of the *Transactions* for 1883 was not issued till May 30, 1884, and was not delivered in London until more than six months later.

THE KILIMANJARO EXPEDITION

At a meeting of the Royal Geographical Society held on Monday night, Mr. H. H. Johnston gave a description of his visit to Kilimanjaro, on the slopes of which he spent more than five months in the summer and autumn of last year.

Mr. Johnston began by explaining the circumstances in which, as appointed leader of the expedition projected by the joint Kili-

manjaro Committee of the British Association and the Royal Society, he found himself on arriving at Zanzibar without any trained collectors to assist him. Giving a lively and picturesque narrative of his adventures during his stay with Mandara, chief of Moshi, a person of remarkable character, who rules a small tract on the lower slopes of Kilimanjaro at an altitude of about 6000 feet, and is at war with all the surrounding potentates, Mr. Johnston told how, after some difficulties, he began the ascent of the mountain with forty carriers and some guides provided by another chief, Maranga. They crossed the cultivated zone, which ended at about 5500 feet in that part, entered a healthy district with pleasant grassy knolls and many streams of running water, and encamped beside a lovely fern-choked brook at 6500 feet, the whole ascent being very gradual. The following day they passed through stunted forest, not unlike an English woodland, where the trees, however, were hung with unfamiliar ferns and creepers, and where deliciously scented parasitic begonias trailed their pink flower-bells from branch to branch. The dracæna, which is cultivated by the Wa-Chagga to form hedges, here grew wild. Tree-ferns were abundant and handsome. Above 7000 feet the orchilla moss draped the forest trees in long gray festoons. Tracks of elephents were very numerous. The other noticeable inhabitants of the forest were dark blue touracoes and tree-hyraxes. Wart-hogs were occasionally met with up to 8000 feet. At 9000 feet they encamped for the night by a small spring of water in the midst of a grand bit of forest, not of that stunted character which marked the lower woods. He caught a chameleon and many beetles here, and also shot touracoes and pigeons. The next day they walked several miles eastward to find a good place for settlement close to water, and not too high up, so that his shivering followers might not suffer unreasonably from cold. He selected an admirable spot on a grassy knoll rising above the river of Kilema, which takes its source near the base of Kimawenzi. The altitude of this spot was nearly 10,000 feet. Having seen every one carefully installed and protected from the—to them—severe cold (for the thermometer descended every night to one or two degrees below freezing-point), he transferred his own quarters to a higher elevation, and began industriously to collect. His first excursion was to the base of Kimawenzi. The terrible hurricane of wind, however, that raged round this jagged series of lava peaks, prevented him from continuing the ascent, although he doubted if it were possible for any one to reach the summit, owing to the want of foothold. The snow varied very much in quantity on Kimawenzi. Sometimes the whole peak would be covered down to the parent ridge, with only the precipitous rocks peeping blackly through the mantle of white. At other periods the snow would be reduced to an insignificant patch, and the reddish sand which filled the crevices and glissades between the lava rocks would be left exposed to view. This change from an almost complete snow-cap to nearly no snow at all might be effected in twelve hours. His great object, however, was to reach the snows, and, if possible, the summit of Kibô. To do this it would be necessary to sleep on the way. He had therefore to induce a few followers to accompany him to carry impedimenta. Starting at 9, he walked upwards with few stoppages until 1.30. At first they crossed grassy undulating hillocks, the road being fairly easy. Then they entered a heathy tract, scorched and burnt with recent bush-fires; but higher up, where the blaze had not reached, the vegetation was fairly abundant and green. Small pink gladioli studded the ground in numbers. At an altitude of nearly 13,000 feet bees and wasps were still to be seen, and bright little sun-birds darted from bush to bush, gleaning their repast of honey. A little higher they found warm springs, the thermometer showing the temperature of the trickling mud to be 91° F. Mounting high above the rivulet the scenery became much harsher. Vegetation only grew in dwarfed patches as they passed the altitude of 13,000 feet, and the ground was covered with boulders, more or less big, apparently lying in utter confusion, and without any definite direction. They were not very difficult to climb over, and even seemed to act as irregular stone steps upwards. In their interstices heaths of the size of large shrubs grew with a certain luxuriance. About 13,700 feet he saw the last resident bird, a kind of stonechat apparently. It went in little cheery flocks, and showed such absence of fear that he had to walk away from it before shooting to avoid shattering his specimen. After this, with the exception of an occasional great high-soaring kite or great-billed raven, he saw no other bird. On reaching a height a little above 14,000 feet he stopped again to boil the thermometer and refresh himself with a little lunch. Throughout this ascent, which was easy to climb, he suffered absolutely nothing from want of breath or mountain sickness, although his three Zanzibari followers lagged behind, panting and exhausted, and complained much of their lungs and head. "Mounting up a few hundred feet higher than the last stopping-place," Mr. Johnston said, "and rounding an unsuspected and deep ravine, I arrived close to the base of a small peak which had been a continual and useful point to aim at during the whole journey from my station. I was now on the central connecting ridge of Kilimanjaro, and could see a little on both sides, though the misty state of the atmosphere prevented my getting any good view of the country. This ridge, which from below looks so simple and straight, is in reality dotted with several small monticules and cut up into many minor ridges, the general direction of which is, on the southern side, from north-east to south-west. To the eastward I could see the greater part of Kimawenzi rising grandly with its jagged peaks and smooth glissades of golden sand. Westward, I still looked vainly in the piled up clouds, for the monarch of the chain still remained obstinately hidden, and I was at a loss as how to best approach his awful crown of snow. At length, and it was so sudden and so fleeting that I had no time to fully take in the majesty of the snowy dome of Kibô, the clouds parted, and I looked on a blaze of snow so blinding white under the brief flicker of sunlight that I could see little detail. Since sunrise that morning I had caught no glimpse of Kibô, and now it was suddenly presented to me with unusual and startling nearness. But before I could get out my sketch-book and sharpen my chalk pencil, the clouds had once more hidden everything, indeed, had inclosed me in a kind of London fog, very depressing in character, for the decrease in light was rather alarming to one who felt himself alone and cut off at a point nearly as high as the summit of Mont Blanc. However, knowing now the direction of my goal, I rose from the clammy stones, and, clutching up my sketch-book with benumbed hands, began once more to ascend westwards. Seeing but a few yards in front of me, choked with mist, I made but slow progress; nevertheless, I continually mounted along a gently-sloping hummocky ridge, where the spaces in between the masses of rock were filled with fine yellowish sand. There were also fragments of stone strewn about, and some of these I put into my knapsack. The slabs of rock were so slippery with the drizzling mist that I very often nearly lost my footing, and I thought with a shudder what a sprained ankle would mean here. However, though reflection told me it would be better to return to my followers and recommence the climb to-morrow, I still struggled on with stupid persistency, and at length, after a rather steeper ascent than usual up the now smoother and sharper ridge, I suddenly encountered snow lying at my very feet, and nearly plunged headlong into a great rift filled with snow that here seemed to cut across the ridge and interrupt it. The dense mist cleared a little in a partial manner, and I then saw to my left the black rock sloping gently to an awful gulf of snow so vast and deep that its limits were concealed by fog. Above me a line of snow was just discernable, and altogether the prospect was such a gloomy one, with its all-surrounding curtain of sombre cloud and its uninhabited wastes of snow and rock, that my heart sank within me at my loneliness. Nevertheless, I thought, 'only a little further, and perhaps I may ascend above the clouds and stand gazing down into the crater of Kilimanjaro from its snowy rim.' So, turning momentarily northwards, I rounded the rift of snow, and once more dragged myself, now breathless and panting, and with aching limbs, along the slippery ridge of bare rock which went ever mounting upwards. I continued this for nearly an hour, and then dropped exhausted on the ground, overcome with what I suppose was an ordinary attack of mountain sickness. I was miserably cold, the driving mist having wetted me to the skin. Yet the temperature recorded here was above freezing-point, being 35° F. I boiled my thermometer, and the agreeable warmth of the spirit-lamp put life into my benumbed hands. The mercury rose to 183°·8. This observation when properly computed, and with the correction added for the temperature of the intermediate air, gives a height of 16,315 feet as the highest point I attained on Kilimanjaro. I thus came within a little more than 2000 feet of the summit, which is usually estimated to reach an altitude of 18,800 feet." He made other ascents during the month he was in high altitudes. The footprints and other traces of buffaloes were seen up to 14,000 feet, but he never caught sight of one of the creatures, nor did he see any of the big antelope,

who also wander up to the snow line. At a height of 13,000 feet he saw three elephants, and at night the shrill trumpeting of these animals could be heard round the station. On October 18 he found himself, most unwillingly, obliged to leave the elevated settlement and return to Taveita. The relatively great cold they had experienced had reacted very unfavourably on his men's health, and he feared that a longer delay might render them quite unfitted to carry burdens. He intended, however, to make his return journey entirely through a new and hitherto untraversed country, and this project somewhat consoled him for leaving the summit of Kilimanjaro still unconquered. Their downward journey, part of the way through trackless bush and dense dank forest, was not without adventure and some reward in scenery of great beauty. The average elevation of this country was between 8000 and 7000 feet, and the temperature consequently almost cool, ranging from 43° at night to 70° in the mid-day warmth. After some four hours' walking from their camp they crossed the long ridge that marked the southern flank of Kimawenzi, and began to descend the eastern slope of the mountain. Soon they emerged on a kind of heath-like country, and then looked forth on a splendid view stretching from Mwika to the mountains of Bura and Ukambani (the Kiulu range), with Jipe on one hand and the River Tzavo on the other. After some enjoyable excursions from his settlement at Taveita, finding that his funds would not support the expedition beyond the end of November, he made a rapid journey to the coast by way of Pare, Usambara, and the Rufu river to Pangani. At Zanzibar, finding there were no fresh funds to enable him to return to Kilimanjaro, he paid off the last of his faithful followers, many of whom had accompanied Thomson on his great journey, and took his passage on the British India steamer to Suez in quite a sulky frame of mind, as sorry to leave his beautiful mountain as many people are to quit England. Travelling overland from Suez, he arrived in London not much more than six weeks after he had caught his last glimpse of the snows of Kilimanjaro.

A SCANDINAVIAN LAND OF OPHIR

WE learn from *Naturen* that the little island in the Hardanger Fjord, known as Bömmelöen, which two years ago was an uninhabited and desolate spot, is now a busy scene of extensive gold-digging. Numerous English artizans and Norsk bricklayers and carpenters have for months been actively engaged in boring and sinking shafts into the rock, and in preparing houses and shelter for the men and machinery that have been drawn hither by the report of the discovery in 1882 of gold in the Storhangen mine. This discovery had been anticipated in 1862 by the find of a piece of pure gold, which was at once deposited in the mineralogical museum of Christiania, where it has since remained apparently unheeded, although the place and time at which it was found are duly marked on the corresponding label. After twenty years gold was again found in 1882, at the Storhangen mine, which was then being worked for copper ore. The result of this discovery was the purchase, in 1883, of the works by an English firm, trading under the title of the Oscar Gold Mining Company, which is worked under the scientific direction of Mr. Murchison. Considerable amusement seems so have been created among Norsemen by a somewhat ambiguous statement, set forth in the Company's circulars, which oracularly announces that "the gold finds at Bommelöen are either Nature's greatest success or her greatest illusion"!

The geological formation of Bommelöen is similar to that of other auriferous rocks, the gold being found in quartz, which occurs in strata never more than six feet thick, although of considerable extent, and generally underlying green (chloritic) schist. The greenstones of the island differ from those found in other parts of Norway, and contain glass and various typical vulcanic products.

The operations of the Oscar Mining Company have given a new stimulus to the search for gold in Norway, and we learn that Herr Bakke, Inspector of Mines at Trondhjem, has officially reported the discovery of virgin gold in a piece of chloritic slate from Stegen in Nordland, while it is authoritatively stated that gold has been found within the last year or two at Sveen in the Bergen-Amt, and also near Stavanger. In the latter case the discoverer, Nils Berg, an old experienced Australian gold-digger, washed the gold from the mud remaining at the bottom of a shaft that had been sunk in a copper mine.

SCIENTIFIC SERIALS

Wiedemann's Annalen, vol. xxiv. January 1885—O. Lehmann, on the melting-points of bodies in contact, and on the electrolysis of solid iodide of silver. A remarkable paper, accompanied with an elaborate plate describing phenomena of crystallisation observed chiefly with microscope at limiting edge of two crystallisable liquids or solutions. Iodide of silver presents certain closely-related phenomena under electrolysis, both in molten and in solid condition. Regular crystalline iodide of silver conducts an electric current, the silver being carried in the direction of the negative current through the crystal without its structure being disturbed. In its electrolysis, however, there appears a streaking in the direction of the flow of the current.—W. von Bezold, on a new kind of cohesion-figures. These experimental researches relate to the quasi-dendritic forms observed when one liquid descends through another.—L. Boltzmann, on the possibility of founding a kinetic theory of gases on attractive forces alone. This is an attempt to dispense with Maxwell's hypothesis that molecules repel one another in the inverse fifth power of the distance, which he framed to account for the apparent perfect elasticity exhibited by molecules of gases. Boltzmann proposes a new theory, based on attraction, very similar to that recently independently propounded by Sir W. Thomson (NATURE, August 28, 1884).—O. Chwolson, on the calibration of the plug-rheostats of Siemens and Halske. This discusses corrections for the resistance of connecting-pieces, &c.—F. Kohlrausch, the electric conductivity of water distilled *in vacuo*. A column of pure water 1 metre long and of 1 square millimetre section has a resistance of about 4×10^{10} ohms.—G. Kirchhoff, on the change of form which an elastic body experiences when it is magnetically or dielectrically polarised. This paper, originally published in the *Proceedings* of the Berlin Academy, deals analytically with the phenomenon of electrostriction investigated by Lorberg and others.—A. Schuster, on the discharge of electricity through gases. Treats of certain points in dispute between the author and Profs. Goldstein and E. Wiedemann. The author pronounces in favour of the view that all the phenomena of effect of magnetism, &c., upon the discharge of the negative electrode may be explained if it be admitted that the negatively-charged portions of the gaseous molecules are driven off from the kathode.—E. Goldstein, on electric conduction in the vacuum. Discusses some experiments in which a carbon filament lamp was employed; the filament forming one electrode, a platinum wire being inserted through the glass to serve as another electrode for the discharge, which was obtained, without an induction-coil, with electromotive forces of about 300–350 volts.—Werner Siemens, contributions to the theory of magnetism. Describes experiments on partially-closed magnetic circuits of iron, giving rise to the opinion, that the harder a specimen of iron is, the greater is the value of the magnetising force at which the maximum of permeability is observed. Also, the magnetic resistance of air is from 480 to 500 times as great as that of iron.—H. Hertz, on the dimensions of unit of magnetic pole strength in different systems of measurement.—E. Ketteler, the optical constants of magnetic media. Develops equations relating to Kundt's recent magneto-optic observations.—E. von Fleischl, the double refraction of light in fluids. Proves that in optically-active liquids the rotation is due to the existence of double refraction. Double-refracting liquids have no optic axis, and the wave-surface consists of two concentric spherical sheets.—W. von Voigt, on the measurement of the refractive indices of absorbing media. Recommends the prism method as more accurate than the total-reflection method.—W. von Voigt, on the theory of reflection and refraction at the boundary of crystalline media. New equations based on the author's theory of the reactions between matter and ether in transparent media, and leading to same conclusions as Kirchhoff's older theory.

Journal de Physique, November, 1884.—J. Jamin, on hygrometry. The author proposes to substitute for the "relative humidity" a new coefficient termed the "hygrometric richness," which is the ratio of the actual pressure of aqueous vapour of the air to the difference between the total atmospheric pressure and the actual vapour pressure. The substitution appears to be both rational and instructive.—Ch. Rivière, essay on cooling power of gases. Confirms formula of Dulong and Petit up to 400° C., but above that temperature the observed values are lower than the theoretical. Also appears to prove that at very low pressures cooling power is independent of the chemical composition.

of the gas.—C. Decharme, imitation of the phenomena of electricity and magnetism by means of liquid and gaseous currents. Summarises number of experimental researches.—A. Kundt, electromagnetic rotation of plane of polarisation of light transmitted through films of iron, cobalt, and nickel; an abstract from the Berlin *Berichte*.—E. Bazzi, on the heat developed by a current during the variable period. Experiments show Joule's law still to hold good, assuming Helmholtz's equations true. It has been remarked by Blaserna that this is not incompatible with the existence of oscillations in the extra-current, for Helmholtz's expression, though only a first approximation which omits the terms that would express these oscillations, is probably not far from the mean result.—The remainder of this number consists of abstracts of papers by Amagat, Baille, H. Becquerel (on infused rays), Cornu, Witz, and by Berthelot and Ogier from the *Annales de Chimie et de Physique*.

December, 1884.—E. Villari, new researches on the electric figures of condensers. The ramifications observed in the dust-figures are believed to be due to partial internal discharges.—E. Villari, microscopic researches on the traces of electric sparks engraved on glass, and on the diameter of these sparks. Tinted zones are observable where these sparks have passed over the surface of the glass. These traces vary with the glass, not with the nature of the electrodes; they are not removed by acids, and are probably due to heat. The cross section of the spark is, for a constant potential, proportional to the charge which produces it.—E. Villari, on the total heat developed by one or more sparks generated by the discharge of a condenser.—E. Villari, singular mechanical effect of the electric discharge. Glass plates, even strong thick ones, are easily broken by the spark of a Leyden battery, provided one face be silvered.—A. Righi, on a recent interpretation of Hall's phenomenon. Bidwell's theory of Hall's phenomenon appears to fail in the case of bismuth, in which Hall's phenomenon exists most markedly. It is also to be remarked that the variation of the electric resistance of bismuth, when subjected to the magnetic field, is greater than that of any other metal.—R. Weber, the electric siren. This instrument produces tones in a receiving telephone by causing rheotomes having different numbers of peripheral contacts rotated at a uniform speed to interrupt the circuit of a battery. The author draws a number of conclusions relatively to the partial and resultant tones, which are hardly justified when one considers the non-sinusoidal character of the variations of the current.—F. Melde, acoustical experiments, abstracted from *Wied. Ann.*—P. de Heen, determination of the general law governing the dilatation of any chemically definite liquid. The author assumes that the molecules attract one another in the inverse seventh power of the distance. Whatever may be thought of the hypothesis, there is an interesting coincidence running through his figures.—The remainder of the number is filled with abstracts of papers from the *Nuovo Cimento*, the most important of them being by E. Wiedemann, on the density of the luminiferous ether, and by Profs. Bellati and Romanese, on some remarkable thermic properties of the iodides of silver and copper.

Rendiconti del Reale Istituto Lombardo, December 11, 1884.—Report on the results of the International Medical Congress held at Copenhagen during the month of August, by Prof. G. Sangalli.—On the influence of high temperatures on the development of microbes, by Prof. L. Maggi.—A study of the earthquake which occurred at Ischia on July 28, 1883, by Prof. Giuseppe Mercalli.—On the secular variation in the elements of terrestrial magnetism at Como, by C. Chistoni.—Descriptive catalogue of sixty-three hitherto unpublished Pontifical coins and medals in the Royal Numismatic Cabinet at Milan, by E. B. Biondelli.—The paintings of the Italian masters in the public museums of Europe, in connection with Senator Morelli's recent work, by Prof. G. Mongeri.—Critical notes on the fourth book of the pseudo-Theophilus, by Prof. C. Ferrini.—Meteorological observations made at the Brera Observatory, Milan, during the months of November and December 1884.

Journal of the Russian Chemical and Physical Society, vol. xvi. fasc. 7.—On the heat of combustion of organic matters, by W. Longuinine; being a description of the methods resorted to by the author in his series of determinations preliminary to the subsequent publication of the results obtained. The paper is accompanied by several plates.—Analysis of a saltpetre earth from Turkestan, by N. Lubavin. It is taken from the ruins of Kunya-Urgench, the climatic conditions being altogether very favourable for its formation, and its abundance explains the cheapness of gunpowder at Khiva. It contains 6 per cent. of azotic anhydride. The remarks of the author as to the connection between the formation of saltpetre and the inundations of the Amu are worthy of notice.—Review of the Russian chemical literature for the year 1883 and first quarter of 1884.—We notice the appearance of a fifth edition of the excellent manual of analytic chemistry by M. Menshutkin, as also of his lectures on organic chemistry (lithographed), which are now in print; a third edition of P. Alexeyeff's organic chemistry, and a second edition of the principles of chemistry, by A. Potylitsin, not to speak of several translations. As to separate monographs, besides those already mentioned by NATURE, the following are worthy of notice:—The organic compounds in their relations to the haloid salts of aluminium, by G. Gustavson—a work which has obtained the premium of the Chemical Society; on the relations between the compositions and refractory power of organic compounds, published at Kazan, which has raised a serious and useful discussion between Russian chemists; and an inquiry into the atoms and the measurement of their size, by O. Troyanovski (Warsaw).—On the electrical discharge in gases, by M. Goldbammer; being a series of experiments for determining the temperature in Geissler tubes. When rarefied air is taken for the experiment, its heating does not depend on its elasticity so long as this last remains within the limits of 8·4 to 38 millimetres; but it decreases with the decrease of the electrical current. The distribution of temperature on the surface of the tube is shown by a series of curves. An interesting observation made by the author is that phosphorescent light on the surface of the glass, such as Prof. Crookes considered as appearing only at pressures equal to millionth parts of an atmosphere, appeared also at pressures from 1·3 to 0·8 millimetres, the glass of the tube not belonging to the category of uranic glass, and the phosphorescent light appearing invariably on the catode, even when the direction of the current has been changed.—Preliminary report on the influence of compression of iron and steel on their magnetisation, by P. Bakhmetieff.—On the hail of July 11, 1884, at Kharkoff, by N. Piltchikoff—a description, with figures, of the hailstones.—On the shock of absolutely rigid bodies, by N. Joukovsky; being a mathematical critique of the theories advanced on this subject by MM. Matson, Prof. Shiller, at Kieff, and M. Garrigou-Lagrange.—On the dilatation of liquids, by M. Avenarius, against Prof. Mendeléeff's formula and in favour of the expression $v = a + C \log. (T - t)$.—On the regular forms taken by powders, by Th. Petrushevski.

SOCIETIES AND ACADEMIES

London

Royal Society, January 8.—"Experimental Researches in Magnetism." By Prof. J. A. Ewing, B.Sc., F.R.S.E., University College, Dundee. Communicated by Sir William Thomson, F.R.S.

The paper describes in detail experiments of which preliminary notices have already been published in the *Proceedings* of the Royal Society, vol. xxxiv. p. 39, and in the *Philosophical Magazine*, November, 1883. The experiments relate to—

(1) The magnetic susceptibility of iron and steel, the form of the magnetisation curve, and the changes of magnetism caused by cyclic changes of magnetising force.

(2) The influence of vibration on magnetic susceptibility and retentiveness.

(3) The influence of permanent strain on magnetic susceptibility and retentiveness.

(4) The energy expended in producing cyclic changes of magnetisation.

(5) The ratio of residual to total induced magnetism.

(6) The changes of induced and residual magnetism caused by changes of stress.

(7) The effects of constant stress on magnetic susceptibility and retentiveness.

(8) The changes of magnetism caused by changes of temperature.

(9) The effect of temperature on magnetic susceptibility.

The experiments were conducted on pieces of metal which gave as near an approach to the condition of uniform magnetisation as is practically attainable.

Curves are given which show the behaviour of iron and steel in various states of temper when subjected to a first application

of magnetising force, and also to subsequent cyclic changes of magnetising force, such as complete or partial removal and re-application, or reversal. The curves are drawn by plotting either $\mathfrak{I}$, the intensity of magnetisation, or $\mathfrak{B}$, the magnetic induction, in relation to $\mathfrak{H}$, the magnetising force: the characteristics of these curves and their relation to the physical state of the piece under examination are pointed out. Curves so drawn invariably exhibit the static lagging action to which the author (in a former paper) gave the name "hysteresis," any cyclic change of $\mathfrak{H}$ giving rise to a more or less nearly closed *loop* in the curve. Attention was previously drawn to these loops by Warburg, who also anticipated the author in pointing out their important physical meaning, namely, that the area of a loop, or $-\int \mathfrak{I} d\mathfrak{H}$, is the measure of the energy expended in performing the cycle of magnetisation which the loop describes. In the present paper numerous absolute measurements of this energy are given, especially of the energy which is thus dissipated in each reversal of the magnetism of a piece of iron or steel. These show that while the dissipation of energy by reversal of magnetism is very much smaller in soft iron than in hard iron or steel, even in the latter its amount is very trifling, so that the principal part of the heat which is produced in the cores of electro-magnets must be due chiefly to other causes than this static hysteresis, and is, in fact, due almost wholly to the induction of so-called Foucault currents in the cores. The relation of this hysteresis to Weber's theory of molecular magnets, as extended by Maxwell, is discussed, and the insufficiency of Maxwell's extension noticed.

By vibrating a piece of soft iron during the application and removal of magnetising force, the effects of hysteresis are almost entirely removed, and the iron is then found to possess almost no retentiveness. But when the application and removal of magnetising force are effected without mechanical disturbance, the retentiveness of soft iron is found to be even greater than that of steel. In some cases 93 per cent. of the whole induced magnetism of a piece of annealed iron was found to remain on the complete removal of the magnetising force. It is pointed out that there is no discrepancy between this result and the well-known fact that a *short* iron core of an electro-magnet retains almost no magnetism when the current in the magnet is interrupted. In that case the ends of the magnet itself, after the interruption of the current, exert a sufficient reversed magnetising force to destroy almost entirely the residual magnetism. But when tested under the conditions which give uniform magnetisation and avoid the demagnetising influence of the ends, soft annealed iron is more retentive than even the hardest steel.

Examples are given showing that the influence of permanent set in the curve of magnetisation is so marked as to give a criterion by which a strained piece may be readily distinguished from an annealed piece of metal, and that strain diminishes very greatly the magnetic retentiveness of iron.

Numerical values of the coefficients of permeability (μ) and of susceptibility (κ) are given for a number of samples of iron and steel, and the relation of these coefficients to $\mathfrak{B}$ and $\mathfrak{I}$ is exhibited graphically after the manner of Rowland. The greatest value of μ refers to soft annealed iron while under mechanical vibration, and is about 20,000.

The next part of the paper deals at great length with the effects of stress (consisting of longitudinal pull) on the magnetic susceptibility and retentiveness of iron; and the last part deals more briefly with the effect of temperature on magnetism, a subject already largely treated by G. Wiedemann and others.

The experiments, which have been of a very extended character, were made during 1881-83 in the laboratory of the University of Tokio, Japan, with the help of Japanese students, Messrs. Fujisawa, Tanakadate, Tanaka, and Sakai, to whom the author is indebted for much valuable assistance. The results have been, almost without exception, reduced to absolute measure, and are for the most part presented graphically in curves which accompany the paper.

January 22.—"On the Origin of the Proteids of the Chyle and the Transference of Food Materials from the Intestine into the Lacteals." By E. A Schäfer, F.R.S.

The most important result obtained by the author is the establishment of the fact that, during absorption of food from the intestine, the lymph corpuscles migrate in large numbers into the lacteals, and for the most part become disintegrated and dissolved in the chyle. This is the case not only after a meal containing fat, but also after feeding with substances devoid of that alimentary principle; it is, therefore, a phenomenon of general occurrence during absorption, and the carrying of fatty particles into the lacteals after a meal containing fat by the immigrating leucocytes, must be regarded as merely incidental to a more general function.

The immigration and solution of numerous leucocytes in the contents of the lacteals must be the means of conveying a large amount of proteid material, derived from their dissolved protoplasm and nuclei, into the chyle. And any other material which may be mechanically or otherwise incorporated with their protoplasm must also be set free. In this way the fatty particles which they contain during absorption of a meal containing fat become released and suspended in the chyle, and it is probable that amyloid matters are also in part thus conveyed to that fluid.

A fuller account of the whole subject, furnished with illustrations and containing the necessary references to other articles dealing with the same question, will appear in the forthcoming number of the *Monthly International Journal of Anatomy and Histology*.

Geological Society, January 14.—Prof. T. G. Bonney, F.R.S., President, in the chair.—Ewan Cameron Galton, Henry Brougham Guppy, Henry G. Hanks, and William Elliott Howe were elected Fellows of the Society.—The following communications were read:—The metamorphism of dolerite into hornblende schist, by J. J. Harris Teall, F.G.S.—Sketch of the geology of New Zealand, by Capt. F. W. Hutton, F.G.S., Professor of Biology in the Canterbury College, University of New Zealand. The paper commenced with some general remarks on the importance and variety of the geology of New Zealand, and on the progress made in the investigation of the islands. The author then proceeded to the question of the classification of the sedimentary strata, which the author arranges in the following local systems:—

Systems	Probable age
Recent	Recent
Pleistocene	Pleistocene
Wanganúi	Newer and Older Pliocene
Pareóra	Miocene
Damarú	Oligocene
Waípara	Upper Cretaceous
Hokanúi	Lower Jurassic and Triassic
Maítai	Carboniferous
Tákaka	Silurian and Ordovician
Manapoúri	Archæan

Most of these systems are divided into several local series. The general geological structure was then treated. The south island of New Zealand was shown to be traversed from near the southern extremity to Tasman's Bay by a curved anticlinal, convex to the westward; and the strata to the east of this axis are thrown into secondary folds, which mainly affect the beds older than Tertiary. A great north and south fault occurs west of the anticlinal. The north island is very different. It is traversed by a narrow ridge, the country northward of which is broken by three great volcanic cones, Mount Egmont, Ruapehu, and Tongariro near the centre of the island. The oldest rocks seen south of Cook's Straits are not repeated to the north, and a fault may traverse the Straits. The rock systems up to the Hokanúi, inclusive, are similar in lithological character throughout New Zealand, and appear to have been formed on the shore of a continent with large rivers. The higher systems, with the exception of a few coral-reef limestones, are locally variable, and may be considered insular. The relative distribution of sedimentary and eruptive rocks was briefly noticed, and the occurrence of some useful minerals mentioned. No workable coal is found below the base of the Waípara system. A description of the different systems and of the series into which they are divided followed, commencing with the oldest. The distribution, lithology, and thickness of each system were noticed briefly, and lists of the most important fossils were added. The eruptive rocks associated with each system were next noticed in the same order, and the paper concluded with notes on the distribution of volcanic rocks in the north island, on hot springs, and on the minerals found in New Zealand.—The drift deposits of Colwyn Bay, by T. Mellard Reade, F.G.S.

Zoological Society, January 20.—Prof. W. H. Flower, F.R.S., President, in the chair.—Mr. Sclater called attention to the breeding of a pair of the Chinese Blue Magpie in the Society's Gardens in 1884, and exhibited specimens of their eggs.—Prof. Bell exhibited some models illustrating the paper of Rathke on the development of the great blood-vessels in the

Vertebrata.—Mr. Tegetmeier exhibited a specimen of the Wild Cat (*Felis catus*) from Donegal, and an example of a singular variation in plumage of the Black Grouse (*Tetrao tetrix*).—A paper was read by Dr. P. Pelseneer on the coxal glands of *Mygale*. Dr. Pelseneer's observations had been made on a large specimen of *Mygale* of the subgenus *Theraphosa* received from the Society's Gardens. The form and position of this organ in the Arachnides had not been previously described or figured.—Mr. E. J. Sidebotham read a description of the muscular system of the Water-Opossum (*Chironectes*), as observed in a specimen of this Marsupial which he had recently dissected.—A paper was read by Mr. G. A. Boulenger containing the description of a new species of Frog from Asia Minor, belonging to the section *Ranæ temporariæ*. This was proposed to be called *Rana macrocnemis*.—A communication was read from Dr. O. Boettger containing the descriptions of five new species of shells of the genus *Buliminus*. The specimens upon which these descriptions were based had been collected by Vice-Admiral T. Spratt in various parts of the Levant.—A communication was read from Mr. J. H. Thomson, C.M.Z.S., containing the description of a new species of Mollusk of the genus *Hyalina*, obtained at the island of Vaté, New Hebrides, by Mr. E. L. Layard, F.Z.S., which he proposed to call *Hyalina* (*Conulus*) *layardi*.—Dr. Gwyn Jeffreys, F.R.S., F.Z.S., read the ninth of his series of papers on the Mollusca of the *Lightning* and *Porcupine* Expeditions. This part included the representatives of the families from Ianthinidæ to Cerithiopsidæ, with seventy-five species, of which twenty-three were new to science. One new genus (*Stilus*) was also described.

Anthropological Institute, January 13.—Prof. Flower, F.R.S., President, in the chair.—The election of Daniel Wilson, LL.D., of Toronto, as an honorary member, and of W. E. Darwin and M. A. Rouffignac as ordinary members, was announced.—The President exhibited the photograph of a "tailed" boy from Saigon. The child was about eight years old, and the appendage from six to eight inches long.—Dr. Garson exhibited, on behalf of Dr. Arthur Thomson, some composite photographs of skulls.—Mr. Oldfield Thomas read a paper on a collection of skulls from Banks, Mulgrave, and Dauan Islands, Torres Strait, recently received by the Natural History Museum from the Rev. S. McFarlane, who obtained them from a sacred skull-house on Jervis Island. The skulls were shown to be of the most pronounced Melanesian type, being characterised by their elongated shape, heavy frowning brow-ridges, low orbits, long, narrow palates, and exceeding prognathism. The various numerical indices showing these points were fully worked out and compared with those of the Fijians, Australians, and other allied races. A new index, the "naso-malar index," was proposed to show the relative prominence of the central as compared with the lateral parts of the face, and the terms *pro-opic*, *mesopic*, and *platyopic* were suggested for skulls or races showing various degrees of development in this respect. Full measurements of the thirty-eight adult skulls in the collection were given, and the averages both of the measurements and indices were worked out in detail.—The Director read a paper by Mr. A. L. P. Cameron on some tribes of New South Wales.

Royal Microscopical Society, January 14.—Rev. W. H. Dallinger, F.R.S., President, in the chair.—Mr. Beck exhibited a very simple electric light apparatus for microscopic work, the battery being very readily set up and worked, and the materials harmless and cheap. He also showed a simplified form of the Caldwell automatic microtome, by which long ribbons of sections were automatically cut and received on an endless band in their exact order, the new form being a little more than a third only of the price of the original.—Dr. Van Heurck sent photographs further illustrating his resolution of *Amphipleura pellucida* into "beads"; also specimens of the same object burnt on the slide and then coated with a very thin film of silver, both by Dr. A. Y. Moore's original process and by an improved method of his own. Dr. Moore also sent one of his slides.—Mr. Swift exhibited a condenser made in 1883, which he claimed to be identical with that of Dr. Wallich.—Mr. H. L. Brevoort desired information as to investigations on the fur of animals as distinguished from hair, it being a matter of great practical importance in the manufacture of felted goods to understand the method by which the fur-fibres act upon another.—Mr. H. G. Hanks announced the discovery at Santa Monica of a deposit of diatomaceous earth like the celebrated fragment found in 1876, and sent a portion for distribution.—Dr. Gray warned mounters against the use of balsam of Tolu, which formed crystals in a comparatively short time.—Dr. Anthony, in reference to Mr. Wright's note on a new structure in the tongue of the blowfly, showed that it was the same as that discovered by him in 1874.—Dr. J. D. Cox further criticised Dr. Flögel's researches on thin sections of diatoms, and stated that he differed from him (1) in finding a thin but indisputable film covering the outer surface of the hexagons of *Triceratium*, as well as on the inner surface; (2) he thinks there should be no doubt of the existence of a film on the outer convex surface of *Coscinodiscus*; the real dispute has been as to the "eye-spot" film, which is the inner one, Dr. Flögel reversing the relative positions of the two films. The idea of the existence of solid spherules must clearly be abandoned from any method of examination.—Mr. Cheshire described and exhibited the spermatozoa from the queen wasp and hive bee, and Mr. Curties exhibited his improved form of the Hardy collecting bottle and Abbe condenser as fitted to second-class English stands.—Mr. A. D. Michael read a paper on the life-histories of some of the little-known Tyroglyphidæ. In 1873 Riley published a report on the ravages of the apple-bark louse (*Aspidotus conchiformis*), and described an acarus which was supposed to destroy that pest, and which he thought might be the *Acarus malus* of Shimer. Riley only describes the female. Mr. Michael has found the Acarus in England under the bark of reeds, destroying the reeds, not feeding on any insect, and concludes that it is probably a feeder on various kinds of bark, not on animal life; he has traced the whole life-history. The male (previously unknown) presents the exceptional features possessed by *Tyroglyphus carpis*, discovered by Kramer in 1881, and the hypopial nymph has been figured by Canestrini and Fanzago in 1877, under the name of "parasite of an Oribata," but without explanation. Mr. Michael finds in the life-history of this hypopus a confirmation of his views that the hypopial stage is not caused by exceptional adverse circumstances, as Mégnin supposes, but is an ordinary provision of nature to insure the distribution of the species, which it is intended to call *T. corticalis*.—Mr. Michael also called attention to the prevalence of *Rhizoglyphus Robini* on Dutch bulbs imported into England in 1884, and to the destructive nature of that species and the damages it did to hyacinth, dahlia, and erecharis bulbs, &c., and recommended that imported bulbs should be carefully examined.—Dr. Maddox read a paper on some unusual forms of lactic ferment (*Bacterium lactis*), of which he showed drawings and photo-micrographs. Some of the chains had the different joints increased largely in size in different parts of the chain in an irregular manner, whilst in others some joints had become more or less globular, as well as very enlarged. Dr. Maddox inclined to consider the enlarged cells as the result of a generative effort (by which the organism can be tided over such conditions as would otherwise lead to its destruction) rather than as a degenerative state or return to a primary phase.—Mr. C. Thomas read a paper on a new species of *Acineta*, which, however, Mr. Badcock considered to be *Trichophrya epistylidis*. Mr. Crisp exhibited and described Robinson's photo-micrographic camera, Gibbe's membrane stretcher, live cell for keeping objects cool, and other apparatus.—The death was announced of Dr. F. Ritter v. Stein, the author of "Der Organismus der Infusionsthiere," and an Honorary Fellow of the Society.—The nominations for the new Council were read, the Auditors appointed, and five new Fellows elected.

Royal Meteorological Society, January 21.—Mr. R. H. Scott, F.R.S., President, in the chair.—The Secretary read the report of the Council, which showed the Society to be in a very satisfactory condition. The Council equipped a typical climatological station in the grounds of the International Health Exhibition, in order that persons desirous of organising a station might see one arranged in accordance with the regulations of the Society. A conference on meteorology in relation to health was arranged for by the Society, and held at the Health Exhibition on July 17 and 18. The Council have appointed committees to investigate the subjects of the brilliant sunrises and sunsets of 1883-84, and of the local phenomenon known as the helm-wind of Cross Fell, Cumberland. The observing stations of the Society now number eighty-five, the results from which are printed in the *Meteorological Record*. The whole of the stations in the south of England have been inspected during the year, and found to be generally in a satisfactory state. The number of Fellows on the roll of the Society is 552, of whom thirty-

seven were elected in 1884. The President, Mr. R. H. Scott, then delivered his address, in which he stated his intention to treat of the general state of the science of meteorology over the globe as compared with the programme sketched out by Prof. James Forbes in the *Report* of the British Association, 1840. He said there were now six meteorological societies publishing journals, and, in addition, six periodicals almost exclusively devoted to the science. He went on to say:—"With all this wealth of literature there is one particular in which, in this country at least, our science labours under a great disadvantage. So far as I am aware, no instruction is given in it except at the Royal Naval College, Greenwich. In Germany, in the current half year, no less than eleven courses of lectures are announced at as many Universities or high schools." Mr. Scott exhibited a large map showing all the observing stations over the globe, and also the distribution of information as to ocean meteorology as contained in the Meteorological Office. He then alluded to the diffetent classes of observations proposed by Prof. Forbes for different classes of stations and the degree to which his suggestions had been carried out.—The next subject was the attempts which have been made by balloon ascents, mountain stations, &c., to gain a knowledge of the condition of the upper atmosphere; and Mr. Scott stated that, on inquiry from the various foreign institutions which possessed affiliated mountain stations, he had found that, except in the case of Mount Washington, none of the observations were practically much used in forecasting. No telegrams are received from Pike's Peak. In one particular all authorities are agreed, that no one has yet suggested any mode in which the barometerical readings could be used, owing mainly to the uncertainty about their reductions to sea-level from great heights. Mr. Scott concluded his address with a notice of the important work by Padre Viñes, S.J., of the Havannah, on the West Indian hurricanes of 1876 and 1877.—The following gentlemen were elected the Officers and Council for the ensuing year:—President: Robert Henry Scott, F.R.S.; Vice-Presidents: William Morris Beaufort, F.R.A.S., John Knox Laughton, F.R.A.S., Edward Mawley, F.R.H.S., Charles Theodore Williams, M.D.; Treasurer: Henry Perigal, F.R.A.S.; Trustees: Hon. Francis Albert Rollo Russell, M.A., Stephen William Silver, F.R.G.S.; Secretaries: George James Symons, F.R.S., John William Tripe, M.D.; Foreign Secretary: George Mathews Whipple, F.R.A.S.; Council: Edmund Douglas Archibald, M.A., George Chatterton, M.Inst.C.E., John Sanford Dyason, F.R.G.S., Henry Storks Eaton, M.A., William Ellis, F.R.A.S., Charles Harding, Richard Inwards, F.R.A.S., Baldwin Latham, M.Inst.C.E., Robert John Lecky, F.R.A.S., William Marcet, F.R.S., Cuthbert Edgar Peek, F.R.G.S., Capt. Henry Toynbee, F.R.A.S.

SYDNEY

Linnean Society of New South Wales, November 26, 1884.—C. S. Wilkinson, F.L.S., F.G.S., President, in the chair.—The following papers were read:—On a new and remarkable instance of symbiosis, by William A. Haswell, M.A., B.Sc. *Phoronis australis*, found by the author in Port Jackson, and briefly described in a preliminary note in the *Proceedings* of this Society (vol. vii. p. 606), forms colonies, the individuals of which inhabit chambers or tubes in a common soft matrix formed of fine felted filaments. The whole colony grows round a large sea anemone in such a way as to form a complete tube for it, the *Phoronis* doubtless profiting by the action of the thread-cells in the tentacles of the anemone, in killing or stunning any minute organisms that come in contact with them.—On the Pycnogonidæ of the Australian coast, with descriptions of new species, by William A. Haswell, M.A., B.Sc. In this paper, which is a review of all the Australian species, seven new species are described: *Nymphon validum* and *æquidigitatum*; *Nymphopsis armatus*, a new genus and species; *Ammothea longicollis* and *assimilis*; *Colossendeis tenuissima* and *Phoxichilidium tubiferum*.—Notes on the Port Jackson Crustacea, by Charles Chilton, B.A. Some new species are here described, and observations are made on the sexual and other peculiarities characterising certain genera.—Descriptions of Australian micro-Lepidoptera, by E. Meyrick, B.A.; No. xii. Œcophoridæ (continued). This paper continues the *Œcophoridæ* as far as the genus *Ocystola*: fifty additional species are described, of which forty-six are new to science.—A monograph of the Australian Sponges, Part iii., by R. von Lendenfeld, Ph.D. The author gives a complete description of the known Australian species of Calcareous Sponges, fifty-two in number. To the species described by Carter, Haeckel, Poléjaeff, and Ridley, numerous new ones are added. A new classificatory system is established in this paper. The Calcispongiæ as an order are divided into Poléjaeff's two sub-orders, the meaning of which has, however, been slightly changed. To Haeckel's three families and Carter's Teichonidæ three new families are added.—Notes on the direction of the hair on the back of some kangaroos, by N. de Miklouho-Maclay. The peculiarity of inverted hair on the back of some of the kangaroo tribe is traced by the Baron in the genera *Dorcopsis*, *Dendrolagus*, and in one species of *Osphranter* (*Osphranter rufus*). The paper also contains some remarks on the dentition of *Dendrolagus Dorianus*.—Note on *Tribrachycrinus Clarkei*, M'Coy, by F. Ratte, M.E. The previous descriptions of this fossil were taken from imperfect inner casts only. Mr. Ratte has now been enabled to describe thoroughly and illustrate this beautiful crinoid from an outer cast of the calyx in the Australian Museum. The most important additions to previous descriptions are the ornaments of the surface of the calyx, the attachment of the first brachial article, and the plates of the roof of the calyx.—On the larvæ and larva cases of some Australian Aphrophoridæ, by F. Ratte, M.E. This paper describes the larval state of some small species of *Rhynchota* closely allied to the genus *Aphrophora*, and belonging probably to the genus *Ptyelus*. They are as yet imperfectly known; but the description of their larva cases and of some of the larvæ discloses a feature probably quite new to the science of entomology. These cases, unlike those of insects generally, are true shells, containing at least three-fourths of carbonate of lime, and resembling in shape some fossil and recent serpulæ, some being conical, others serpuliform, or helicoidal. The conical shells are fixed on the branches of some species of Eucalyptus, the mouth turned upwards, the larva being placed in it with the head downwards. It introduces its suctorial apparatus into the bark of the stem, sucks the sap of the tree, and emits from time to time, by its anus, drops of clear water. This property of emitting water is possessed by all the family.

PARIS

Academy of Sciences, January 19.—M. Bouley, President, in the chair.—On the approximate degree of accuracy of the differential formulas employed in Paris, Lyons, Kew, &c., in the reduction of the meridian observations, by M. M. Lœwy.—Remarks on the nervous system and embryonic forms of Gadinia Garnotii, by M. de Lacaze-Duthiers.—On the existence of glycyrrhizine not only in *Glycyrrhiza glabra* and *G. echinata*, where it was first discovered by Robiquet, but also in *Polypodium vulgare*, and several other families of plants, by M. E. Guignet. From a protracted study of this substance the author infers that it plays a great part in the vegetable kingdom, and is associated with the principal series of organic chemistry.—On the oscillations occurring at long intervals in machines set in motion by hydraulic agency, and on the best means of preventing these oscillations, by M. H. Léauté.—Statistical studies on the cholera epidemic in the Paris hospitals, and especially on the circumstances attending the outbreak in the Asylum for the Aged in the Avenue de Breteuil, by M. Emile de Rivière. From November 4, 1884, when it made its first appearance, till January 15, 1885, when the last patient was discharged, there were recorded altogether 1080 cases, of whom 636 were males and 444 females. Of these, as many as 587, or 54·15 per cent., succumbed, that is to say, 340 males, or 53·46 per cent., and 247 females, or 55·63 per cent But in the Asylum, out of 215 inmates 79 were attacked (55 men and 24 women), and of these 65 perished (47 men and 18 women), or 82·278 per cent. This excessive mortality is attributed mainly to the great age of the pensioners in the Asylum, ranging from 58 to 90 years.—On the advantage of destroying the winter egg of Phylloxera in vineyards infested by this parasite, by M. Balbiani. The paper is supplemented by a note on the employment of a wash of sulphate of iron, by M. Faudran, who finds this remedy extremely efficacious in destroying not only the winter eggs, but also the insects adhering to the plant.—On Encke's Comet; observations made at the Observatory of Algiers with the 0·50m. telescope, by M. Ch. Trépied.—Supplement to two preceding notes on the theory of the figure of the planets and the earth, by M. O. Callandreau.—On the last results of solar statistics, by M. R. Wolf. The paper is accompanied by a table and diagram showing the number of days in each month of the years 1883 and 1884 when it was found possible to take solar observations at the Observatory of Zurich.

The author considers that a careful study of these tables will suffice to convince the most incredulous of the intimate relation existing between the solar phenomena (spots, faculæ, &c.) and the oscillations of the magnetic needle.—On some new transformations of partially-derived linear equations of the second order, by M. R. Liouville.—On the laws of evaporation as determined by the measurements recorded with ordinary evaporometers at the various meteorological stations, by M. Berthelot.—On oxygenated water, by M. H. Henriot. The results are given of experiments made to distil oxygenised water under a reduced pressure of 3 cm. of mercury.—On an easy method of obtaining measurable crystals of the peroxide of cobalt, Co^3O^4, by M. Friedel. The method consists in submitting the liquid chloride to the action of a current of moist air in the same apparatus in which he has already succeeded in obtaining artificial hausmannite.—On the formation of the nitrate of tetramethylammonium, by MM. E. Duvillier and H. Malbot.—On a method for regulating the chemical action of solar radiation, the intensity of which is constantly changing on the surface of the earth, by M. L. Olivier.—On the origin of the Microzymas and of the Vibrionians everywhere present in the atmosphere, in water, and the ground, in connection with M. Duclaux's recent communication, by M. A. Béchamp. The author argues against M. Pasteur that these germs are to be sought originally, not in the air, where they are disseminated by the winds, but in the ground and water, where they are deposited by the disintegration of the neozoic and palæozoic rocks, and by decomposing animal and vegetable matter of all sorts. He holds tbis, not as a mere hypothesis, but as a conclusion actually determined by strict experiment, by facts discovered by himself, verified and controlled by former opponents of his views.—Note on the vitality of the germs of microbes preserved in the liquid in which they were developed, by M. E. Duclaux. The persistence of these germs for a period of twenty or twenty-five years is clearly determined by the author's researches.—On some physiological phenomena associated with the lesion of certain parts of the animal organism, by M. H. de Varigny.—Contribution to the study of the glands yielding byssus, and of the water-bearing pores in the family of the Lamellibranchidæ, by M. Th. Barrois.—Remarks on some new crepuscular glows recently observed in Central America, by M. F. de Montessus.—On some of the phenomena observed in connection with the recent earthquakes in the south of Spain, by M. A. Germain.—Observations collected on earthquakes during a residence of forty-six years in Chili, by M. Domeyko.—Observations on the earthquakes that occurred in Andalusia on December 25, 1884, and the following weeks, by M. F. de Botella.—Earthquake shocks felt at the Azores on December 22, 1884, by M. da Praia.

BERLIN

Physical Society, January 9.—Dr. Kayser reported on measurements of the electromotive force and of the resistance of an improved Noë thermo-generator, which in its essentials resembled the old Noë generator, differing from it only in that, instead of the wires connecting the bismuth alloy pieces with one another, strips of an unknown alloy were taken, which opposed greater resistance to heat than did the wires. The electromotive force of the generator increased proportionally with the quantity of the gas consumed for heating, that is, proportionally with the temperature. The curve of the electromotive force formed a straight line, and showed a bend only in proximity to the terminal temperature, where the metallic parts began to melt. The resistance of the generator, which, at the temperature of the room, amounted to about 0·9 Siemens unit, rose with increasing consumption of gas, reached a maximum of about 1·2 Siemens unit under a consumption of about 60 cc. gas per hour, and then, under a consumption of 100 cc. gas, sank below the initial value. On repetition of the measurement, the resistance was found to become less and the curve flatter. After a repose, however, of several days, the resistance again grew greater, without, however, reaching the value of the newly-examined battery. On a comparative estimate of the costs of generating electricity by means of a thermo generator and a Bunsen battery, it was ascertained that a current of 1 ampere per hour with the Bunsen battery cost about 3 pfennigs, but with the thermo-battery only somewhat over 1 pfennig. The current of the thermo-battery proved itself, in conclusion, highly constant, no change in the current having been observed in the course of twenty-four hours' uninterrupted heating with the Bunsen flame.—Prof. von Helmholz confirmed the last-mentioned fact. For the purpose of the electrolytic purification of quicksilver, he had made incessant use for a fortnight long of a thermo-battery, and on intercalating a galvanometer had discovered only inconsiderable variations in the current. He described the various methods he had made trial of, for the complete purification of quicksilver, all which, however, turned out ineffectual, till at last he adopted the electrolytic method, applying it in the following manner:—The impure quicksilver lay at the bottom of a glass vessel, and on the quicksilver swam a second vessel for the reception of the pure metal. An isolated platinum wire dipped into the quicksilver, connecting it with one pole of the battery, while the other pole was connected with a platinum plate placed in the empty vessel. The vessel then was filled with nitric acid, and the nitric oxide of quicksilver which was formed became decomposed by the current. The quicksilver separated itself, chemically pure, on the platinum strip, in the form of little globules, which dropped into the swimming vessel, and after covering the bottom in a cohering layer, it formed itself the electrode, at which the pure quicksilver further precipitated itself.—Prof. Neesen reported on a series of thermo-batteries and galvanic elements which had been quite recently patented for Germany, but which presented no innovations in principle. The only element deserving any special notice was Pabst's, consisting of carbon impregnated with oxide of iron, solution of chloride of iron, and iron, a material said to remain long constant for weak currents.—Prof. von Helmholz related that this cell had been sent to the Physical Institute, and for four months had proved itself pretty constant for weak currents. Following this up, he decribed the arrangement he had very recently given to the Daniell cell for the common purposes of the laboratory. At the bottom of a deep glass goblet lay a copper spiral connected with an isolated platinum wire in a glass tube. Above the spiral was placed a solution of blue copperas, which could be filled in by means of a funnel reaching to the bottom. On the solution of copper lay the lighter water-clear acid, or white sulphate of zinc, in which was placed the zinc cylinder. A siphon, the outer leg of which was directed from below upwards, dipped into the fluid as far as the bounding plane of the two fluids, so that, on filling in a fresh solution, only the solution of white vitriol immediately above the blue copperas, and contaminated by it, flowed off. This arrangement had the effect of keeping the upper fluid constantly water-clear, though, indeed, after a while, some copper was found precipitated on the zinc cylinder. The constancy, however, of the cell was not thereby perceptibly impaired.

CONTENTS

THURSDAY, FEBRUARY 5, 1885

SIR HENRY COLE

Fifty Years of Public Work of Sir Henry Cole. Two vols. (London: George Bell and Sons, 1884.)

THIS book, though chatty and discursive enough in parts, will disappoint those who want to learn something of the personality and life of a doughty champion of some dozen reforms. The first part, from the racy pen of Sir Henry Cole himself, teems with lively comments and thrusts, *more suo.* The vigour of a man who believed in his mission, and rejoiced in the work of his own hands, appears on every page. No mark is required to indicate the transition from the dashing, animated narrative of the chief actor to the careful and cautious chapters written by his children. We do not see how either could give us what we chiefly want without offending against certain rules of delicacy which we are glad to know are not yet quite obsolete. The life of Sir Henry Cole, the inner history of his struggles, his successes and failures, the motive power, and an impartial view of the man in relation to his work —this has yet to be written. What he and his children between them have given us is a valuable collection of facts and documents bearing upon the most important progressive movements of our century.

To not a few the second volume will be more interesting than the first. The plan of the work is to give in the first volume a series of chapters which take in Sir H. Cole's principal work, and the corroborative and supplementary documents, with many curious illustrations, make up the second volume. The whole concludes with a most thorough-going verbal index, which would have rejoiced Sir Henry Cole's heart, for to him nothing was complete without an index.

Henry Cole had to face no ordinary difficulties in carrying out his work, but then he was just the man for difficulties. He would have been nowhere in piping times of peace. His appetite for a task grew as the opposition and hindrances grew. Probably no one ever knew him to be faint-hearted or broken in resources. At last it came to be felt that he would in any case carry his point, and timid natures gave way before the impetuosity of a knight whose sword had no scabbard, and who left himself no retreat. You could only beat him by cutting him to pieces—there was no other way. At the Paris Exhibition of 1855 he was known to the officials as *ce terrible Cole*—a man who, regardless of the methods of red tape, took the shortest way to his point, and did not know when he was beaten by all the rules of officialism.

Associated with this indomitable pluck was another quality which the English people love well. He had a never-failing flow of good spirits which burst forth in rollicking good humour, confusing and sometimes irritating to his opponents. We suspect that not a few of the enemies he made had suffered in their self-esteem from the sharpness of his common sense driven home by his reckless love of fun—at least of what was fun in him. Once, when giving an address, in a provincial town, on public libraries, as he was advocating the setting up of reading-rooms where smoking would be allowed, a local magnate on the platform testily interrupted him with a formal protest and the remark that there was a public-house across the road. Sir Henry Cole, pausing in his discourse, surveyed his critic for a moment with a curious air, and then, turning to the audience, said in a loud "aside" and with the most perfect good humour:—"This gentleman seems to be a kind of pope down here." The cause of his antagonist collapsed amidst inextinguishable laughter. On another occasion the Education Code was under consideration, and one, not remarkable for hereditary wisdom, suggested that the poor children should be taught "legal economy," meaning thereby, as was explained, a knowledge of the laws of the land,—"And the Ten Commandments," interpolated Sir Henry Cole in a stentorian voice. People do not readily forgive such setting forth of their folly, but it was a temptation which an impulsive enthusiast could not resist.

In the short space allotted to this notice it would be unwise to indulge in extracts. If we take one, it is because it sets forth in Sir Henry Cole's own words the works of a public nature with which he was connected.

"The principal subjects which I now deal with are the reform of the system of preserving the inestimable public records of this country, dating from the time of the Norman Conquest, and unrivalled in Europe; my work in expediting the successful introduction of Rowland Hill's penny postage; the administration of railways; the application of fine art to children's books and then to manufactures, which led to the transfer of my duties to the Board of Trade; the Great Exhibition of 1851, and its successors; the reform of the Patent Laws; the establishment of schools of art and science classes throughout the United Kingdom; the South Kensington Museum; drill in public elementary schools as the basis of a national army; national training schools for music and for cookery; the Society of Arts, and public health."

To begin with the public records. Entering this office as a mere youth, his spirit was stirred within him when he saw the utter carelessness as regards documents "dating from the time of the Norman Conquest and unrivalled in Europe." For daring to call attention to the jeopardy in which these precious records were placed he was dismissed, and no doubt it was thought the insignificant youth was extinguished; but in the end young Cole dragged the affair before Parliament, and was triumphantly reinstated with something like full powers to carry out the much-needed reform. Our Public Records Office is now a credit to the administration of the country, but fifty years ago (so it was stated in Parliament) public records were boiled down for glue, and the clearer and better sort converted into jellies by the confectioners (Mr. Charles Buller's speech on Public Records, vol. ii. p. 86).

While at the Records Office, Henry Cole threw himself into the uniform penny postage movement. The particular task he undertook was to rouse popular enthusiasm for the reform, and we have Sir Rowland Hill's testimony that "he was the author of almost innumerable devices by which in his indefatigable ingenuity he contrived to draw public attention to the proposed measure." There is an amusing cut in the book (vol. ii. p. 102) representing one of these devices. Mr. Cole obtained a prize of 100*l.* from the Treasury for an essay on the best method of

carrying out some parts of the reform, and ultimately he was taken from the Records Office to assist in remodelling the postal system.

His next dealings were with railway administration, and he took part in the "battle of the gauges," but this work was, we should think, somewhat out of his line. It is dull and heavy reading after the fun and energy shown over postal reform. At length he emerges from dealings with railways and docks into the more pleasant paths of art. Under the *nom de plume* of Felix Summerly he produced handbooks on art. In this connection he threw himself into wood-engraving, and so "mastered the technicalities of etching on copper that my works obtained admission (vol. i. p. 103) to the Royal Academy." In Summerly's handbooks, also, essays in bookbinding were made, and the beautiful designs of Holbein, as well as the fifteenth century patterns for leather still remaining in Durham Cathedral, gave suggestions which were used. The Summerly tea-service, which won a prize offered by the Society of Arts, is still much admired. An engraving is given in vol. ii. p. 178. Out of his work under this head sprang his connection with the Board of Trade and their School of Design.

Henry Cole as Felix Summerly strove to "make art common"—a reproach he would have accepted joyfully. Assisted by the best art of his day, he produced artistic books for children, prepared descriptive catalogues of the art treasures of the country, and endeavoured to realise Gibson's ideal panel, in which is represented the marriage of Art and Commerce. His next move in this direction was to persuade the Society of Arts to get up a national exhibition of British manufactures. Prince Albert was the active President of this Society. It was he who developed the idea into a universal exhibition—the Great Exhibition of 1851. At this part the notes are particularly full. It is as if Henry Cole had never done anything remarkable before or since. If this gigantic undertaking was a gigantic success, the credit is largely due to the energy and ability of Henry Cole, who was rewarded with the decoration of C.B.

The work of the Great Exhibition and the other exhibitions which followed interfered for a while with the development of the two greatest undertakings of this busy creative life. We refer to the South Kensington Museum and the Science and Art Department. The Museum stands by general admission first of such institutions. Here the designer and the artisan may study a vast collection of the products of human ingenuity. The idea seems to have sprung naturally from the Great Exhibition of 1851. If such a show be good for the development of manufacturing and mechanical ingenuity and for creating artistic taste, why not have one in permanence? When the question arose what was to be done with the surplus profits of the Great Exhibition, it occurred to the Prince Consort and the Executive to found a museum for a permanent exhibition. Accordingly, on accepting from the Board of Trade the task of reforming art instruction throughout the land, Cole recommended the purchase of art objects from the Exhibition. The usual objections of red tape stopped the way for a time, but the indefatigable reformer, backed by the Prince Consort and Lord Granville, triumphed as usual, and a Committee was appointed, empowered to spend a sum of 5000*l*. This transaction is the real origin of South Kensington Museum. The collection then purchased (1851) was the nucleus of a museum of art manufactures "which should have its connection through the whole country and help to make the schools of art as practical in their working as those of France and Germany" (vol. i. p. 283). We may here remark that though there is a circulating department at South Kensington Museum it is by no means in a forward state. A few pictures are lent for six weeks at a time to local schools of art, and whenever an exhibition is got up, South Kensington contributes specimens with not too liberal a hand; but Mr. Mundella has promised more, though in indefinite terms. Wherever a local museum is maintained in fair efficiency there should be a division supplied continuously from South Kensington. It is not enough to wait for local action. The department should invite applications and raise public attention by means of a letter (not circular) sent now to this mayor and now to that. The subject would then probably be brought forward in the Town Council and discussion and inquiry would result. This proceeding would be dreadfully unofficial no doubt; but South Kensington, which inherits the traditions of a sagacious chief, is perhaps the most *human* of all government departments. It can stoop to consider ideas from outside. Possibly steps have been already taken in this direction as regards the Liverpools and Birminghams of our land. The writer's experience with much smaller towns has led to the conclusion that *temporary* aid of the kind above indicated is much needed in the interests of art development; *temporary*, for with regard to the Government and local effort, the aim should be to throw the dependency as soon as prudent on its own resources. First the child is nursed and coddled, then he is placed "under tutors and governors," who harden him off, and at last he is left to manage for himself and to pick himself up when he falls. A vigorous son of the north, whose heart was in this work, laid this down as the best policy: "First a stick and then a kick." It is remarkable, indeed, how small a part of the aid given by the Government reaches the institution for which it is intended. For scientific apparatus teachers have again and again gone into the open market and done better than with the Government aid of 50 per cent. through accredited agents. In books we have known a great part of the aid given by the Science and Art Department to be swallowed up by insufficient deduction from the published price and by unusual charges for packing. The supply of art specimens also is faulty in this respect. It is probable that competition would not permanently remove these objections. The Department should in our opinion *give*, and give not needful things but accessories—not the beef but the condiments—and having thus evoked a more cultivated appetite should leave it to seek its own gratification.

Those who wish to know with what painful steps and slow the magnificent collection at South Kensington was got together, will find full particulars in the latter part of the first volume of this interesting memoir. It was started at Marlborough House, beginning with the art specimens which had been collected for the old Schools of Design and the purchases from the Great Exhibition. Subsequently, grants were made by Parliament for purchasing specimens of artistic specimens of all ages, and the never-

to-be-baffled Director gave his superiors no peace, and probably would have been equally importunate and equally unsatisfied if he had reached the age of Methusaleh. This worrying may have been very unpleasant for the political heads of the department, but it has been a good thing for the country. Whoever visits South Kensington Museum and profits by his visit should bless the pertinacity of Henry Cole. Not only the Government was waylaid, but the Queen and Prince Albert, and other collectors and possessors of art objects were invited and persuaded to give the public an opportunity of seeing them for a time in the Museum. Loan exhibitions of furniture, &c., were formed, and photographs, casts, and electrotypes were made of the finest objects which thus came temporarily into the possession of the Museum. This system of reproduction has helped to develop immensely certain divisions of the Museum, and is likely to be of immense benefit to museums generally. Witness the splendid electrotype reproductions of Corporation and College plate in South Kensington Museum. Purchases were made from the Bernal Collection and that of M. Soulages was added to the treasures of South Kensington after an intricate series of negotiations. The pictures which the Rev. John Sheepshanks bequeathed to the nation also found a home here, but his desire that they should be on view for the working people on their day of rest has not been respected. The Editors note the condition on which the bequest was made, and dryly add that after the arrival of the collection at South Kensington it was inspected on many successive Sundays by members of the Legislature and their friends, but it was hardly their Sundays in particular that this public benefactor desired to refine and brighten. South Kensington Museum succeeded to Marlborough House in 1857, and it continued under the rule of "King Cole" till 1873, when he retired on full pay, not altogether willingly, we believe. No doubt he was a despot, but in the early stages of unique institutions a despot is necessary. As it stands, South Kensington Museum is a lasting monument of his foresight, his delight in work, and zeal for the material prosperity of his country.

But the Science and Art Department is Sir Henry Cole's greatest work, and the greatest monument of his genius. How he kept on teasing the Government for money and spending more than was allowed, till at last he had put together a noble collection, and the Museum was a fact—this is generally known; but the history of the Science and Art Department has yet to be told. It was conceived and constructed by a dogged inventive genius which knew how to turn difficulties into stepping-stones to success, and to wear out stolid opposition by vivacious pertinacity.

This Department was formed as a branch of the Education Department, with Henry Cole as its head, its hands, and its feet, under the nominal control of the successive Presidents and Vice-Presidents of the Privy Council. These statesmen we will venture to say had little idea of what was being done in their name. The grants which the manager was able from time to time to obtain were utterly insufficient for ordinary lines. We know the old jog-trot idea which a commonplace mind would have formed: First, to train teachers, and then to found and maintain schools in the different towns of the land: but Cole's plan was to bribe teachers to qualify themselves by promising them payments on the results of examinations in various centres supplied with papers from London to be worked out under local committees at a minimum of expense. Soon the land was covered with schools of art and science classes, to the astonishment of the statesmen who supposed that they had been holding the reins. As a result, the English people were converted from Philistinism, and became ardent lovers of art. In the poorest cottages may now be found vessels of artistic design and other delights of the eye, as cheap as the ugly patterns which obtained everywhere except in the houses of the richest a few years ago. In the recent debates in the French Parliament on the proposed renewal of the Commercial Treaty with England, the French Minister stated that when that treaty was first made, in 1859, France supplied England with almost all its objects of art, but that in the interval, owing to the work of the schools of art, the tables had been turned, and it was now England that was pouring these articles into France. It was *ce terrible Cole* who had stuck to his work, undeterred by abuse and opposition, till he had redeemed England from its dependence on the ingenuity of France.

Sir Henry Cole's retirement from office in 1873 did not mean retirement from work. Out of office, he set himself to do for music and cookery and sanitation what he had largely done for art, namely, to make their principles and practice common and popular. He pictured an England whose toilers, admitted to participate in the benefits of civilisation, found relief in refined enjoyments from the depression resulting from the minute division of labour into dreary monotonous tasks, without variety. The part he bore in establishing the Kensington Training School of Cookery and the School of Music, and his share in promoting the Albert Hall, will best show the earnest work of his later years. His work and his life in fact ceased together.

Whoever will read the list of the tasks which Sir Henry Cole set himself, as enumerated at the beginning of this article, will not find it hard to discern running through the whole of this busy aggressive life one constant, continuous idea. Like the great English reformer who vowed that he would make things plain for a ploughman which had been reserved for the understanding of a cultivated few, Henry Cole lived to make the poor sharers in the best benefits of modern civilisation. He set himself to make common those refining agencies which tend to cheer and sweeten the dull monotony of excessive toil and hopeless poverty. Hence his efforts to stimulate the creative faculties of the nation, to make known our art treasures, to cheapen specimens of art and to call out the dormant sense of delight in the beautiful, so as to reach and raise men through their higher faculties of enjoyment. He who sets himself to "level up" and to destroy privileges by making them common will have enemies enough in his time. Probably Sir Henry Cole had his full share of abuse and misrepresentation. But, unlike many of the world's benefactors, he lived to see much good fruit resulting from his pertinacious toil for the public good, and he will not soon be forgotten by a grateful country.

NEWTON PRICE

EARTHQUAKES AND FIRE-DAMP

On the Observation of Earth-shakes or Tremors in Order to Foretell the Issue of Sudden Outbursts of Firedamp. By M. Walton Brown. Excerpt Minutes of Proceedings of the North of England Institute of Mining and Mechanical Engineers, vol. xxiii. 1884.

A Theory of Mine Ventilation. By M. Walton Brown. (Printed by Lambert and Co., Limited, 50, Grey Street, Newcastle-on-Tyne, 1884.)

THE first of Mr. Brown's two papers contains a proposal to institute the systematic observation of earth-tremors for purposes which he describes as follows:—

"Whatever may be the cause of the issue of sudden outbursts of firedamp the quantity of gas produced is extremely variable and irregular. Many theories have been from time to time advanced with the object of defining the laws which govern these sudden outbursts of gas from coal and adjacent strata.

"It would appear that there is some connection between sudden outbursts of gas and the motions to which the crust of the earth is subject: in other words, that slight motions of the earth's crust may be followed by more or less violent outbursts of gas. Thus, if there were a large body of gas pent up in a subterranean reservoir, and some movement of the earth's crust took place forming fissures of varying depth and width, affording channels for the escape of this gas, upon such a fissure being reached in the workings of the mine, a blower would be the result, the volume and duration of which would depend upon the volume of the reservoir, pressure of the gas, and width of the fissure. If this theory is the true solution of the problem, it follows that the systematic and regular observation of earth movements would eventually prove a reliable means to some extent of foretelling when outbursts of gas should be anticipated."

If gas existed in subterranean reservoirs such as those imagined by Mr. Brown, then, undoubtedly, when the workings of a mine reached a fissure communicating with such a reservoir all that Mr. Brown anticipates would happen. Supposing it possible, however, that a fissure could be formed by an earth-tremor at the depths at which firedamp exists in a sufficient state of tension to give rise to an outburst when tapped, it does not by any means follow that the observation of earth movements could assist us in foretelling when such outbursts would be likely to happen. For the position of any given fissure, relatively to that of the workings, must obviously be an unknown quantity, so that, for anything we could know to the contrary, the fissure might either be broached on the day of its formation or not for many years afterwards.

This paper is illustrated by two plates: one, a seismographic map of Western Europe, showing the distribution of earthquakes, copied from the map prepared by the Messrs. Mallet; the other a diagram showing, by curves, the relative frequency of earthquakes and fatal explosions of firedamp, and the mean height of the barometer monthly from January of one year to April of the following year. The explanation of the second plate appears to be incomplete. As regards the barometric curve, we consider this a good opportunity of remarking that all attempts to correlate mean barometrical observations extending over longer periods than a few hours with explosions in mines appears to us to be labour lost, and similarly we are satisfied that the bald statement so often met with, that the barometer was rising or falling at the moment any particular explosion happened, is devoid of value, and leads simply to confusion. This subject was most carefully investigated by Mr. R. H. Scott, F.R.S., and the writer some years ago, and the results were published in various papers at the time (*Proc. Roy. Soc.*, 1872; *Quart. Journ. Met. Soc.*, 1873 and 1874). The diagrams which accompany these papers show very distinctly that the barometric curve ought to be known accurately for several days before the occurrence of an explosion if it is desired to form a true opinion as to the probable influence of atmospheric agencies in the case.

In his second paper Mr. Brown does good service by calling the attention of the English reader to the manner in which the problem of ventilating mines has been simplified by the recent researches of M. Murgue, the able director of the Bessèges Collieries in France. M. Murgue's articles were contributed to the *Bulletin de la Société de l'Industrie Minérale*, second series, vols. ii., iv., and ix.; and his views are also very clearly set forth in the second volume of M. Haton de la Goupillières's excellent and concise "Cours d'Exploitation des Mines," just published.

It is evident from the nature of the case that the details of no two mines can be exactly alike as regards the resistances which they oppose to the circulation of ventilating currents through them. The diameter and depths of the shafts, the lengths, areas, bends, ascents, and descents, and comparative roughness of the sides, of the air-ways, the temperature, tension of water vapour, and the velocity of the air-currents, must all vary with every varying circumstance. Accordingly, any attempt to compare the total resistance of one mine with that of another by finding the value of each element in the calculation and summing up the results could produce nothing but complication and disappointment.

M. Murgue has solved the problem by referring the sum total of all the resistances to one single and very simple resistance, namely, that of an orifice in a thin plate, which he calls the *equivalent orifice.* He describes it as *the area in square metres of the orifice through which the same manometrical depression will cause the same volume of air to pass in the same time as in the mine.* This area is found as follows:—Let a be the area required, q the quantity of air, v its velocity in passing through the orifice, and 0·65 as the value of *vena contracta.* Then—

$$q = 0{\cdot}65\, a\, v.$$

Taking w the specific gravity of the air (estimated by M. Murgue at 1·2 kilo. per cubic metre), and h the manometrical depression (expressed in kilograms per square metre, or, what is the same thing, in millimetres of water), we have:

$$h = w\frac{v^2}{2g}, \text{ or } v = \sqrt{2g\frac{h}{w}},$$

whence

$$q = 0{\cdot}65\, a \sqrt{2g\frac{h}{w}}.$$

Then by introducing the numerical values of w as given above, and of g as 9·8088 metres, we get—

$$q = 2\cdot63\, a\, \sqrt{h},$$

whence

$$a = 0\cdot38\, \sqrt{h}.$$

But we can always ascertain by observation the values of q and h in any given case, so that the value of the equivalent orifice can be easily found.

M. Murgue has determined this value for a large number of mines and has given the results in tables in his second article, already referred to. The values vary somewhat above and below a square metre, but a large number of them are very little different from that unique area. The author calls those mines whose equivalent orifice is greater than a square metre, *wide*, or roomy, and those in which it is less than a square metre, *narrow*, or confined.

M. Murgue has applied the same mode of comparison to the resistances which the air has to overcome in passing through the various kinds of ventilating machines, and in this case he distinguishes the corresponding orifice by the name of *orifice of passage*. The manner in which its value is found is similar to that of the equivalent orifice.

In Mr. Brown's paper will be found a table containing a summary of experiments made, with six different kinds of ventilators, by a Committee of the Société de l'Industrie Minérale, in which the translator has reduced the French measures to their English equivalents. He also gives two diagrams: one showing the volumes of air produced by the same ventilators kept running at a uniform velocity, while the equivalent orifice is gradually increased; the other showing the curves of useful effect for four of them. On the whole, we consider that the contents of this paper deserve the careful consideration of those who have not an opportunity of consulting the original articles.

W. GALLOWAY

MAGNETO- AND DYNAMO-ELECTRIC MACHINES

Magneto- and Dynamo-Electric Machines. From the German of Glaser de Cew, by F. Krohn. Specially Edited, with many Additions, by Paget Higgs, LL.D., D.Sc. (London: Symons and Co., 1884.)

THIS book is issued as Volume I. of "The Specialists' Series," to be edited by "Dr." Paget Higgs and "Professor" Charles Forbes. From what University Mr. Higgs holds his degree of Doctor of Science does not appear. Presumably, he is the same person as the "Rev. William Higgs, M.A., D.D.," who formerly edited an electrical periodical in London, and afterwards left his country. Readers of the admirable volume on the "Transits of Venus" in the *Nature Series* know the name of Prof. George Forbes, and appreciate his scientific standing. They are not likely to confound him with the Mr. Charles Forbes who appears as joint editor.

The present volume, translated and "specially edited," gives to the public little that it did not previously possess. Of books on electric lighting there are enough and to spare. Dr. Schellen's work on "Magneto- and Dynamo-Electric Machines"—an excellent translation of which is now appearing in New York—was the first good work of the kind, and it has run to a second edition. In title and in matter it is greatly resembled by the present work; but Schellen's work is far more elaborate and complete; whilst the one merit of the Glaser-de-Cew-Krohn-Higgs-Forbes volume is that it includes a brief chapter on accumulators—too brief, considering that the various types are well and concisely explained. For the rest, the additions are chiefly scissors and paste work. Chapter VII., on Constructional Laws, is largely taken from Prof. S. Thompson's "Cantor Lectures"; Chapter VIII. gives the old set of tests executed for Trinity House in 1877 on obsolete types of machine; the only addition, relating to the later and far more perfect tests made at Paris in 1881, Munich and Crystal Palace (London) in 1882, and Vienna in 1883, being an editorial footnote five lines in length. Chapter X. is extracted from Du Moncel's book on "Electromagnets"; Chapter XI. (on Instruments for Measurement) is apparently amplified from the price list of a certain firm of electrical engineers, whose instruments, exclusively, are described. Chapter XIII. is an abridgment of Clausius' theory of the dynamo-machine, reprinted *verbatim* from the abstracts from foreign journals in the *Proceedings* of the Institution of Civil Engineers. The index is most elaborate: it occupies nearly a twelfth of the whole book. There are several glaring errors in the work. Of these is the statement, on p. 100, that in a compound-wound dynamo—in which it is desired to provide a current varying exactly proportionally to the number of lamps that are connected to the mains—there must be maintained "a constant magnetic intensity." On p. 143 it is elaborately set forth that the ratio of the part of the effective electrical energy which is converted into real work to the total electric energy of the current can "never be greater than $\frac{1}{2}$"; and on p. 147, equally elaborately, that "the maximum efficiency of an electro-generator is obtained when its internal resistance is equal to the resistance in the external circuit." If the latter statement were true the maximum efficiency could never exceed $\frac{1}{2}$. The fact is that both statements are untrue and misleading, as are several of the statements relating to efficiency on p. 144. Apparently, either the translator or the editor does not understand either the English meaning of the German word *Nutzeffekt*, or the technical meaning of the English word *efficiency*. On p. 173 the shifting of the neutral point in the rotating armature is referred to the alleged fact (?) that "the magnetism of the iron core and the current in these turns of wire (which have passed the poles) remain at the same intensity for a few moments." The statement is misleading, and the supposed explanation of the shifting of the neutral point is well known to be a fallacy. Still more extraordinary is the statement made, apparently with scientific seriousness, on p. 174, that the heating of the iron core of the armature is another "consequence of the fact that the maximum magnetism does not immediately disappear." There are several mistakes in the definitions of the electrical units as given in the last page of the preface. The *watt* is given as the unit of *work*, instead of the unit of activity; and the extraordinary statement is made that the untit of potential difference "exists between two points when the unit quantity of electricity, in moving from the one point to the other, *requires a unit force* to overcome the electrical repulsion," thus making the definition of potential depend on *force* instead of *work*. Moreover, the static units are called the "C.G.S." units

without any mention of the magnetic units of the C.G.S system, leading the reader to conclude that the *volt* is equal to 10^8 of the static C.G.S. units. These are grave errors in a book designed for specialists. On p. 94 the author, or editor, announces the insertion of some "data given . . . *by physicists known for their veracity*." Are there any others?

OUR BOOK SHELF

Key to Magnus's Class-Book of Hydrostatics and Pneumatics. (London Science Class-Books.) By John Murphy. 67 pp. (London: Longmans, Green, and Co., 1885.)

MR. MURPHY has rendered useful service to science teachers by the publication of the solutions of the exercises and problems given in Mr. Magnus's widely-known volume. These problems cover the whole ground of elementary hydrostatics and pneumatics; and the solutions are intelligently worked out in full. The work has had the benefit of Mr. Magnus's own revision; and this should be a guarantee of the goodness of the methods followed and of the correctness of the results. The only fault we have to notice is a tendency to looseness in the use of certain terms about which there ought not in physical science to be the slightest vagueness: we refer to the misuse of the words *strain* and *pressure* where the proper word should be *force*. A strain is an alteration of shape or volume, and ought not to be confused with the force which produces the strain. A pressure is a force divided by an area and cannot be specified except by naming both the force and the area on which that force acts. Yet on p. 5 of Mr. Murphy's Key occurs the statement that "the pressure or whole strain to which the sphere is subjected equals the weight . . . of the liquid." It is greatly to be desired that this ambiguity between pressure and force should as speedily as possible be removed from this and all other elementary books, as it is misleading to beginners as well as incorrect.

Electrical Units. By Dr. R. Wormell, M.A. (London: T. Murby, *no date*.)

THIS little work of 48 pp. is apparently issued as an appendix to the author's class-book of "Electricity and Magnetism." It contains a concise and easy account of the units in ordinary use, and of the notion of dimensions of units so puzzling to beginners. A number of useful data of constants are given, and there are some numerical problems for calculation added. Dr. Wormell's genius as a teacher comes out in several points: the transition from magnetic to electro-magnetic units being particularly neatly brought about on p. 10. A few slips should be corrected at once. In the table on p. 1 the electro-chemical equivalent of hydrogen is given as ·00001055, and on p. 14 as ·0000105. According to the late results of Kohlrausch and Lord Rayleigh it is ·00001035. On p. 6 the horse-power is wrongly stated as 746 kilogramme-metres per second. On p. 15 there is a curious muddle about units of capacity, arising partly from a confusion between electrostatic and electromagnetic units. It is certainly *not* true that a sphere of one centimetre radius has a capacity about equal to that of "the whole Atlantic cable"; neither is the *farad* the millionth part of the *microfarad*. It also must strike the practical electrician as rather a curious statement that (p. 33) the Swan lamp is usually fed by the Gordon dynamo. We were under the impression that only one Gordon dynamo had yet been built, and that it had not been used since last winter. The connections of the Brush armature on p. 37 are wrong; and the author should not describe Edison's armature as being like that of Gramme, when the fact is that it pays royalty to Siemens as a Siemens armature.

Weekly Problem Papers, with Notes, intended for the Use of Students Preparing for Mathematical Scholarships and for the Junior Members of the Universities who are reading for Mathematical Honours. By the Rev. J. J. Milne, M.A. (London: Macmillan, 1885.)

MR. WALTER BESANT in a recent work entitled "In Luck at Last," makes his heroine (a Maria d'Agnesi or a Somerville) remark, "No life can be dull when one is thinking about mathematics all day. Do you study mathematics?" For such a one this handy volume of a hundred papers, each of which has at least seven questions, some of which bifurcate or trifurcate, will be a charming companion. Though the range is limited to the requirements of a University scholarship—this by the way is fairly extended at the present day—yet there is sufficient "variety" in the selection of problems to make it what we state it to be above, "charming." The book, as such a work ought to be, has been printed with very great care, and, after a close perusal, we have detected only two or three slight clerical errors. The compiler, who is to be congratulated on his successful achievement of a somewhat difficult task, proposes to bring out at a future date a second volume containing his solutions to the exercises. Wolstenholme's collection is, except under the guidance of a judicious tutor, too hard and too full of tricks for the class whose wants this manual is designed to meet; the boy who has mastered this collection, or a fraction of it, will have realised what sort of questions he will be called upon to "tackle" when he has an examination paper before him.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Free Hydrogen in Comets

TOWARDS the end of an admirable mathematical paper on the theory of the forms of comets, received this morning by post from M. Bredichin, that very able Director of the Imperial Observatory of Moscow (specifying himself, too, in English at the head of a pamphlet in the French language as "Associate of the Royal Astronomical Society"), draws the conclusion that the great comet of 1881 was a structure of compound hydrocarbon gas, while Halley's historic comet was "of a type which corresponds to pure hydrogen."

The distinguished author's position with regard to the comet of 1881 I presume will be contested by no one; for all the spectroscopes of the time proved so abundantly that the light of that comet was of the kind familiarly known among technists as "the candle-spectrum," or the spectrum of the compound gas CH, in the form of acetylene, perhaps, but entirely peculiar to carbo-hydrogen. Who, however, can help the theorist of Moskva's white-stoned city and golden domes to establish the probabilty of a spectrum of pure and elemental hydrogen gas for Halley's comet, before that wanderer in far off space shall return in the beginning of next century, and then instantly testify its chemical composition to the spectrum analysis of that day?

One of the difficulties which M. Bredichin has to deal with meanwhile, seems to be, that no trace of a pure hydrogen spectrum has ever yet been seen in any comet, however much of CH there may have been; and he is driven to suggest that the H, or hydrogen lines—so entirely different from those of CH—were invisible on account of their faintness. But though that idea, with some modification or explanation, may ultimately turn out to be correct, it requires something more just now to create many converts to it, particularly in face of the universal experience of all dabblers in spectroscopy with vacuum tubes; for they know so well that, whatever the reputed gas in them may be, intrusive lines of hydrogen, though present as an un-

avoidable impurity only, are usually the most incisive and brilliant part of the display.

In a paper, however, on "Micrometrical Measures of Gaseous Spectra," kindly printed, but not yet published, for me by the Royal Society, Edinburgh, there is a full description of a case which will be found to supply exactly the practical details that may strengthen M. Bredichin's views.

After having had tubes, and tubes, and tubes again of CH gas, of various varieties of CH and at various pressures made by different makers, and having found their CH spectrum (under the electrical incandescence which M. Bredichin also assumes for his comets) always more or less imperfect and more and more haunted, often overpowered, by the brilliant lines of pure hydrogen, I followed out the indications of least failure by eventually having made a so-called vacuum, but really four inches of mercury pressure tube of olefiant gas. It was constructed for me, with very peculiar attention to, and precautions for, purity, by Mr. Charles F. Casella, of 147, Holborn, and attained absolute success at last, for no trace of any impurity whatever could I discover in it from one end of the spectrum to the other.

Not only so, too, but the spectrum which it did show was the most brilliant and perfect one of CH that I have ever heard of. Every one knows the five diversely coloured bands of CH, four of them first well described by Prof. Swan in 1856; each band beginning towards the red with strong lines and bright haze, which fades off towards the violet side into black, vacant space long before the next band begins. And many persons know that with greater spectroscopic power that haze is capable of being resolved into a system of smaller lines, and far closer, or linelets, but still coming to an end considerably short of where the next band begins.

But on this occasion, with the extra heavy olefiant gas-tube, strong induction sparks, and a spectroscope having 24° dispersion from A to H of solar spectrum, a telescopic magnifying power of 14, a very narrow slit and excellent definition of prisms, the linelets, usually so difficult to identify, were as sharp and clear as luminous needles, and continued, in a series of regularly-increasing spaces apart, the whole distance from one CH band to the next. This completeness was distinctly proved, first with the Orange band and its needle-like scale of linelets (after all its strong lines had been left behind), extending up so as to touch, as it were, the brilliant beginning of the Citron band. Then came *its* bright lines and closely-packed linelets continually widening in distance apart, but losing nothing in sharpness and definition until the Green band was reached. With the Green band was its leader (the so-called "Green Giant of Carbo-hydrogen") burning like a pillar of electric fire; then its close linelets; then its second line and linelets rather wider apart; its third line and linelets still wider; and onwards linelets wider yet, but preserving admirable regularity of series all the way, all the long way, without missing, or slurring, one step, the whole distance right up to the beginning of the Blue band.

Yet over one part of that lengthy road something extraneous did appear; vaguely at first, or as a mere faint ghost of a barely perceptible roll of gray-coloured cirrostratus cloud! Could it be subjective only? possibly the reflection from a fatigued part of the retina of the observer's eye. Not that, for the linelets of CH were still brilliantly sharp, thin, and narrow everywhere. What then? I, who had condemned scores of vacuum tubes of all the gases for being filled with H lines, had never seen anything like that floating, filmy cloud before!

But thought is quicker than sight. A suspicion of the truth flashed in a moment upon me; and on turning to the Red end of the Spectrum, there, over the known place of Hydrogen's Red line, was another faint broad region of barely visible luminous haze, but reddish, in place of, like the other, a blue-gray. Even, too, as I watched them, from that moment on through an hour, first turning to one and then to the other, those haze-clouds narrowed and narrowed towards their central verticals, whilst the sharp little linelets of the CH *pari passu* became paler and paler, until at last they only remained visible in the neighbourhood of the bigger lines and strong beginnings of their respective bands. And by that time the once faint clouds, the red and the gray, had become transformed into two piercingly bright lines of Hydrogen light, the representatives of Solar C and Solar F; while the carbon of the CH, which the H had been eliminated from by the action of the electric spark, was deposited on the inside of the tube as a brown glaze.

This, then, is the case of independent observation which I beg to hand over to M. Bredichin for discussion, believing it to illustrate that

(1) In the condition most suitable for showing the CH, or ordinary cometic, spectrum,—no H should appear.

(2) If a little free H should be introduced into a full atmosphere of CH, the characteristic lines of H are at first so *extra* broadened—though seen under the same circumstances that those of CH are *ultra* narrow and defined in—as to be weakened thereby below visibility, unless, indeed, the CH spectrum at the time be almost infinitely brighter than it has ever yet been found in any Comet.

(3) The longer the incandescing electric influence is at work, the greater is the evolution of pure H on one side, and deposition of solid C on the other, out of CH gas. Whence we may possess for the future an indicator for the comparative age of Comets; or, at least, may pretty certainly conclude Halley's Comet to be older than that of 1881, if bright, narrow lines of pure H, with or without CH bands accompanying, shall be visible in the spectrum of the former at its next return: that, in itself a consummation long most earnestly wished for, but now more than ever to be desired, to test the penetrating theory of a Russian Astronomer and Mathematician.

C. Piazzi Smyth

15, Royal Terrace, Edinburgh, January 19

Iridescent Clouds

On pp. 148 and 149 of the current volume of Nature there are two letters describing "iridescent clouds," and the idea is conveyed that this phenomenon is only of late occurrence. That this is hardly justifiable, the following account from a diary will show:—

At Knoxville, Tennessee, on the afternoon of February 16, 1878, after many days of cloud and drizzle—something unusual in that country—the sun being about 10° high and the sky partially covered with large haze-clouds, there was noticed in the south-west, against one of these clouds, a slightly curved band of prismatic colours about 90° in length; which, but for its position in the west, might have been mistaken for a rainbow—concave toward the sun, the sun, however, not at the centre of curvature, and about 30° distant from it. The green was most strongly marked; this shaded off on each side, and on the side of the band next the sun was red; upon the opposite side the colour was less distinct, but there it seemed to be reddish.

Again, during September or October 1882 (this from memory), at the same place, about sunset, with a patched, cloudy sky, the sun not visible, the prismatic colours were noticed in the south-west near a break in the clouds. This time the colours were in the form of an elongated ellipse, with indistinct edges, between 2° and 3° in greatest length.

Then, during the fall of 1883, the prismatic colours were once noticed under similar circumstances to those mentioned here in Virginia.

W. G. Brown

University of Virginia, Virginia, U.S.A., January 12

The Iridescent Clouds alluded to above

In our northern as well as insular position, with weakened sunshine and an atmosphere always more or less darkened by coal-smoke, we must be prepared to allow much for what is, and is to be, seen of the grander meteors of meteorology in the more southern latitude, clearer air, and intensified climate of the Virginian portion of so great a continent as America. But before any one there can claim to see frequently that very phenomenon of the iridescent clouds, communicated last December to Nature by various persons, but by myself perhaps as the chief culprit, he must be quite sure, amid the crowd of known and already described parhelia, mock suns, broken rainbows, &c., that what he sees has the same discriminating optical characteristics as those particular clouds now in question; and that any one of his cases was, in America, so unusually brilliant a display of them, and so widespread an instance of it, that from one end of the States to the other it was on the same day similarly seen, wondered at, and declared even by gray-headed old men to be new to them, in at least anything approaching that astonishing degree of splendour and perfection, though by no means new to creation over a longer lapse of time.

The Virginian letter-writer, however, speaks merely of what he himself saw, describes the colours as prismatic, in place of the anti prismatic arrangement witnessed here, and alludes to one case of a curved band "about 90° in length," which contrasts exceedingly with the forms and sizes noted in this country.

In fact I can hardly give a stronger confirmation of the rarity, and both the general character and universality of the phenomenon on that occasion, for all parts of Great Britain than by concluding with the following extract from a letter by Prof. A. S. Herschel of Newcastle-on-Tyne, dated December 25:—

"I saw," he writes "(and photographed from a window, but lost by over-exposing the plate, unfortunately), the iridescent clouds of Thursday's sunset you describe in NATURE, and nothing more beautiful than the diamond-beetle *elytra*, or Papilio-pario wing-scales, which glittered in the western sky could, as you wrote, be possibly *imagined!* They were seen also in the south of England (Kent) between 2 and 3 o'clock on the same afternoon.

"Mr. N. here says, in resumption of what they were probably, that he often sees such coloured fringes and colour-bows, in circles too, on clouds near and round the sun, by looking at the sun's reflection and that of the clouds just round him, in the plate-glass window of his drawing-room.

"So no doubt it was a good instance only of a common sight, but an instance yet, I should say, not to be seen much oftener than once or twice in a century!"

To that opinion I do not presume to add one word.

C. PIAZZI SMYTH

15, Royal Terrace, Edinburgh, January 28

Manx Cats

WITH reference to Mr. Francis Galton's remarks in NATURE on Manx cats, I should like to ask whether any of your readers can assist me. Some little time ago I imported a few Manx cats with a view of trying experiments with them in crossing. But, as Mr. Galton says, it is difficult to get cats to breed in confinement, and of course it is of no use for the purpose of my experiment to allow the animals to roam at large among ordinary cats. Acting upon Mr. Galton's suggestion, therefore, I write to ask whether any of your readers happen to know of any island within a reasonable distance from town where a breed of Manx cats could be established. It is not necessary that the island should be a marine one. Any piece of ground insulated by fresh water would do equally well, provided it were of moderate size and not already tenanted by cats. If any of your readers should know of such a place I should be greatly obliged to them for a reference to its locality.

I may take this opportunity of further inquiring whether any of your readers would care to lend me, or tell me where to procure, a really good talking parrot for the purposes of systematic observation. GEORGE J. ROMANES

Cross-breeding Potatoes

IT is well that your correspondent, Mr. James Melvin, has called attention to the dubious and erroneous ideas which now largely prevail on this subject. There is no reason to suppose that hybrids arising from *Solanum Maglia* will be disease-proof, for *S. Maglia*, like *S. tuberosum*, is one of the known hosts of the potato fungus, *Peronospora infestans*.

The errors appear to have arisen from the unfortunate conclusions,—"Economic Suggestions," given by Mr. J. G. Baker in his otherwise admirable paper laid before the Linnean Society, April 1884, p. 505.

Mr. Baker thinks that, because *S. Maglia* comes from humid positions in America, it will succeed in Britain better than *S. tuberosum*, a plant of the dry hills. The correctness of this idea I should very much question, the great strongholds of fungi being humid places. The fact of the habitat is an important one, but the deduction made from it is questionable.

Mr. Baker says the potato plant in its present tuber-bearing state is in a "disorganised and unhealthy condition." This view also is very much open to question: there is no evidence of disorganisation and unhealthiness in cultivated potatoes. Cultivated potato plants are no more disorganised and unhealthy than are any of our other cultivated kitchen garden plants, fruits, flowers, or domestic animals, including man himself. The notion that disorganised and unhealthy plants are "fitting subjects for the attacks of fungi and aphides" is a mistake, for fungi (*i.e.* parasitic fungi,—the fungi Mr. Baker has in view) do not grow upon "disorganised and unhealthy plants;" they require healthy plants on which to grow. Of course vegetable parasites require for their sustenance the vigorous elaborated juices of healthy plants, not the vitiated juices of "disorganised and unhealthy" ones.

Leaving theory for fact, I may point out that in the published results of experiments made by Dr. Hogg last autumn, both *S. Maglia* and *S. Jamesii* were badly diseased with parasitic fungi, and in Mr. Thomas Laxton's published experiments nearly the whole of the plants of *S. Maglia* and *S. Commersoni* (the two species specially recommended by Mr. Baker), as well as *S. Jamesii*, "disappeared from disease."

A year or two ago Mr. John King, British Vice-Consul, Carrizal, Bajo, Chili, sent to this country twenty stones of potatoes from positions in Chili where, during an experience of more than twenty years, the disease of potatoes had never been seen. It was perfectly unknown to the growers there.

These twenty stones of potatoes were planted in different parts of Great Britain and were a failure. They fell before *Peronospora infestans* quite as readily as did our own common potatoes.

No doubt good will arise from the experiments now being carried out, but not in the way generally assumed. The only theme for regret is the publication at the outset of (as I think) curiously mistaken deductions. These deductions, coming from such an excellent botanist as Mr. Baker, have led potato growers very much astray. WORTHINGTON G. SMITH

Earthquake

THE annexed copy extracts from letter dated Kingston, Jamaica, January 8, from Capt. Spray, of our s.s. *Maroon*, will no doubt interest you. Are we right in thinking that the shock he felt was probably connected with the Spanish earthquakes?

J. G. S. ANDERSON

5, Fenchurch Avenue, London, E.C., January 27

Extract of Letter from Capt. Spray

Kingston, January 8

On the morning of December 22, 1884, in lat. 36° 48′, long. 19° 25′ W., we felt a shock as if the ship was grinding over a reef, although there was no difference in speed of engines; stopped and made every examination, but found no cause. My opinion it was a shock of earthquake, as some years before, nearly in the same place, I felt one more severe than the last.

An Instance of "Protective Resemblance"

IN Mr. Johnston's interesting account of the ascent of Mount Kilimanjaro, in Equatorial Africa, which appears from time to time in the *Daily Telegraph*, occurs a passage which seems deserving of being rescued from the comparative oblivion of the pages of a daily newspaper. It will be found in the number of the 16th inst., and is as follows:—"Other noticeable features in the scene were the tall red ant hills and, strange imitation, the tall red antelopes, a species of hartebeest, resembling faintly in shape the form of a giraffe with sloping hind-quarters, high shoulders, and long neck. Being a deep red-brown in colour, and standing one by one stock-still at the approach of the caravan, they deceived even the sharp eyes of my men, and again and again a hartebeest would start up at twenty yards distance and gallop off, while I was patiently stalking an ant-hill, and crawling on my stomach through thorns and aloes, only to find the supposed antelope an irregular mass of red clay."

New University Club, January 20 J. C. G.

Hibernation

WILL you allow me to invite attention of anthropologists and zoologists to the very remarkable (and to me surprising) statement contained in the article "Hibernation" (W. F. Kirby), last edition of the "Encyclopædia Britannica." Reference is there made to a work by Mr. Baird, entitled "Human Hybernation" (1850), giving examples on "unimpeachable authority" of the powers of religious ascetics in India of throwing themselves into a state closely resembling hibernation for an indefinite period; and quoting a case of a Fakir who was actually buried alive at Lahore in 1837 in presence of Runjeet Sing and Sir Charles Wade, and was dug up and restored to consciousness several months afterwards! Now, it is ascertained that hares can exist for weeks together buried in the snow, and if this power of hibernation can be developed at will, might it not also be so on necessity, and explain the former existence of the Siberian mammoths, through the winter months: these animals might, as winter approached, have withdrawn to sheltered hollows, where

they were eventually snowed up and covered with snow. This possibility may have before been started, but seems to me to be reasonable and probable. K. BUSK

Athenæum, February 2

Our Future Clocks and Watches

IF clocks are to strike at all, surely once per hour is insufficient, while four times is excessive; the high hour-numbers even now are inconvenient to count, and with the quarters heard alone it is possible to make a mistake of an hour. I cannot but think, then, on the whole, that the necessities of ship-life have long driven mariners into the very best method, free from all difficulties, and that, whatever our way of noting hours, we could do no better than adopt the naval half-hour strikings for land-clocks, recommencing with each four-hour watch. Some confusion with the existing ways, as long as they survive, is inevitable, and equal whatever change is made.

A mistake of four hours is just as unlikely as one of twelve. We should probably soon find names for the different four-hour divisions; for example, we might denote each half-hour by some letter or cypher. EDWARD L. GARBETT

THE LIFE-HISTORY OF THE LYCOPODIACEÆ

THE area within which really notable discoveries are possible—at any rate amongst the higher plants—in the field of vegetable morphology is becoming very circumscribed. For some time the complete life-history of the *Lycopodiaceæ* has been a missing chapter in our text-books. Hofmeister, like others, had unsuccessfully sown the spores, and he could only speculate as to the probability of their producing—if the proper conditions could be known—a prothallium like ferns. And Spring, the monographer of the group, had hazarded the extraordinary theory that the existing representatives of the group were only represented by male plants, the females having been lost in some remote geological catastrophe.

De Bary made in this, as in so many other fields, the first real advance. He described in 1858 the early stages of the germination of the spores of *Lycopodium inundatum*. But just as Hofmeister had failed to get the spores to germinate at all, so De Bary failed to get the development of the prothallium to advance beyond a very early stage. Thus matters stood till 1872, when Fankhauser had the good fortune to find, in a botanical excursion, young plants of *Lycopodium annotinum*, still united to their parent prothallium.

For my own part, I have always felt that it might be the chance of any wide-awake observer to turn the next unread page in this curiously reserved history. And I have never failed to remind the younger botanists who have consulted me as to a promising direction for work that this was a possibility they should never lose sight of. Within the last few days, however, two fresh contributions to the subject have come into my hands.

The first number of the *Botanisches Centralblatt* for this year contains a paper by Bruchmann, who has, if I mistake not, already done some good work in the vegetative morphology of Lycopodium. He has had the good luck to repeat Fankhauser's happy find, and to have come across, at the end of August last, living prothallia of the same species.

But the paper[1] which will mark its epoch in the history of Lycopodium is that for a separate copy of which I am indebted to my friend, Dr. Treub, the accomplished director of the renowned Botanic Garden at Buitenzorg in Java. Six years ago, when he had no thought that he would ever be able to prosecute botanical research in the tropics, he also made, as so many others have done, unsuccessful attempts to obtain the development of Lycopodium spores. On his arrival at Buitenzorg, he lost no time in endeavouring to find the prothallia of tropical species. He seems to have all but succeeded in discovering those of *Lycopodium cernuum*—but for an accidental circumstance which threw him off the scent—in the first year of his residence there. Subsequently, he sowed the spores on the trunks of trees, and after a delay which led him to abandon any hope of success, he obtained satisfactory results from one of the sowings. Now he is acquainted with the prothallia of three species of Lycopodium, and hopes to be able to describe even a fourth.

In the present paper, which is illustrated with nine admirable plates, Dr. Treub gives an exhaustive account of the prothallium of *Lycopodium cernuum*. It is curious to observe, however, that in artificial cultures he did not succeed in carrying the development further than De Bary had done some time ago with *L. inundatum*. Fortunately, prothallia which he discovered under spontaneous conditions of development exactly fitted in where the others stopped.

The adult prothallium is a very singular structure, consisting of a sort of short cylindrical axis, half immersed in the soil at one end, where it is furnished with root-hairs. The upper extremity bears a tuft of small leaf-like lobes. The archegonia and antheridia are found on the upper part of the cylindrical axis, forming a kind of ring or crown near the tuft of lobes. The prothallium therefore presents a type morphologically more differentiated than is met with elsewhere amongst the vascular cryptogams. While this is the case with the sexual generation (oophore), the spore-bearing generation (sporophore) in its embryonic stage is less differentiated than is the case, for example, in the fern. The embryonic root is suppressed, and the whole embryo, which is wholly parenchymatous, approximates in its morphological characters to those of the prothallium.

W. T. THISELTON DYER

[1] *Ann. du Jardin Botanique de Buitenzorg*, vol. iv. pp. 107-138, tt. ix.-xvii.

JOHN GWYN JEFFREYS

IT is with much regret we have to announce the death of this veteran conchologist. Dr. Gwyn Jeffreys, who was in his usual health the day before, and in the evening attended at the lecture given by his son-in-law, Prof. Moseley, at the Royal Institution, was seized on Saturday morning, January 24, with a fit of apoplexy, and at five o'clock on the same afternoon passed peacefully away. He was the last, or almost the last, of a band of marine zoologists of a former generation who had been his friends. Dilwyn, Cocks, and Couch; Fleming, Gray, Forbes, Alder, and Albany Hancock; Johnston and William Thompson; Barlee and Waller are names of the past.

Dr. Gwyn Jeffreys was born at Swansea on January 18, 1809, and had thus just completed his seventy-sixth year. While a boy he showed a taste for natural history, collecting the insects and shells of South Wales. When only nineteen he contributed a paper to the Linnean Transactions, "*A Synopsis of the Pneumonobranchous Mollusca of Great Britain*," and from that date until the present time he has been adding by his writings to our knowledge of the molluscan fauna of Europe and the North Atlantic. His most important works are: "*British Conchology*," in five volumes, and a series of papers (unfortunately unfinished) in the Proceedings of the Zoological Society, on "*The Mollusca of the 'Lightning' and 'Porcupine' Expeditions*, 1868-70." At the age of twenty he was elected a F.L.S., and in 1840 F.R.S., and he was an honorary LL.D. of St. Andrews. He was one of the most regular members of the Royal Society Club, and took great interest in the meetings of the British Association, which he almost always attended, taking a more active part in 1848, when Local Treasurer at the first meeting at Swansea, in 1880, when a Vice-President at the last meeting held in the same town, and in 1877, when President of the Biological Section. For many

years he was Treasurer of the Linnean, and also of the Geological, Society.

Dr. Gwyn Jeffreys's profession was the law. He practised as a solicitor at Swansea until 1856, in which year he was called to the bar, but soon afterwards altogether retired from business. He then left London, and went to reside at a fine old house, Ware Priory, which he had purchased in Hertfordshire. Here it was his delight to hospitably entertain his scientific friends and any foreign naturalists of kindred tastes to his own who might be visiting London.

He may be considered perhaps as the father of dredging in our seas. When practising as a solicitor he was diligent in his profession, and could only spare himself short holidays; yet as early as 1841 he paid his first visit to Shetland. Through a number of years, when unable to give much time himself to collecting, he joined Mr. Barlee in partnership, and while his friend gave his whole time to dredging and collecting, Jeffreys shared the expense and the mollusca.

Shortly after Barlee's death Jeffreys was enabled to devote himself more exclusively to scientific work, and from this time commenced an important series of dredging operations which continued to the last. His friends were now the late Mr. Waller and the Rev. A. M. Norman, and in company with these naturalists explorations were made of the most important parts of the British coasts. A yacht, the *Osprey*, at first lent by Dr. Gwyn Jeffreys's brother-in-law, Mr. Nevill, but subsequently purchased by him, was employed in these investigations. The summers of 1861, 1862, 1863, 1864, 1867, and 1868 were spent in dredging, down to 170 fathoms, the sea around the Shetland Islands; in 1865 Guernsey and Jersey were visited; in 1866 the Minch; and in 1870 the deep water off Valentia on the south-west of Ireland.

Private enterprise now gave way to Government expeditions. In 1869 H.M.S. *Porcupine* was sent to explore that portion of the Atlantic which lies off our western shores, and Dr. Gwyn Jeffreys had charge of the scientific work of the first cruise off the west of Ireland. In the succeeding year (1870) the same vessel was sent to investigate the great depths off the southern coasts of Europe, and Jeffreys was the naturalist on board during the first cruise, which was off the Spanish and Portuguese coasts. In 1876 he went in H.M.S. *Valorous*, which accompanied the last Arctic Expedition as far as Baffin's Bay, when very successful dredging was carried on in Davis Strait and the North Atlantic Ocean during the homeward voyage. In 1880 he and his friend, Dr. Norman, by invitation of the French Government, took part, with a staff of naturalists of that country, in dredgings in great depths off the Bay of Biscay in *Le Travailleur*. In 1878 and 1879 Drs. Gwyn Jeffreys and Norman went together to Norway and dredged Oster Fiord to the north of Bergen, the Hardanger Fiord, and at Dròbak on the Christiania Fiord.

Besides all this direct scientific collecting Dr. Jeffreys for many years has been in the habit of taking a tour on the Continent for the purpose of carefully examining all leading and typical collections of European mollusca, and more especially the products of the various deep-sea expeditions of other nations.

He married a daughter of the late R. J. Nevill, Esq., of Llangennech Park, Carmarthenshire, a talented and accomplished woman who predeceased him, and has left six children.

Dr. Gwyn Jeffreys was J.P. for the counties of Glamorganshire, Breconshire, and Hertfordshire, and for the last county was also a D.L., and served as High Sheriff in 1877.

It cannot but be a matter of deep regret to all British naturalists that Dr. Gwyn Jeffreys's magnificent and unequalled collection of European mollusca, amassed with so much labour and toil and expense, rich to overflowing with types not only of species described by himself, but by almost every author, should go out of this country. Two years ago it was purchased by the American Government. We congratulate our Transatlantic cousins on having it, but it would have been of far greater value in Europe.

ALEXANDER MURRAY, C.M.G.

BY the death of Mr. Alexander Murray, Canadian geology has lost one of its veteran pioneers. This estimable man belonged to a good Perthshire family, and was born at his father's estate of Dollerie in 1811. He went into the navy at the age of fourteen, served in the Mediterranean and was present at the battle of Navarino, was subsequently employed in the West Indies, Halifax, and other stations, and finally quitted the service in 1837. There being no prospect of his advancement in the pursuit of war, he turned his attention to the arts of peace, went to Canada, and bought land there with the view of settling as a farmer. During the rebellion which broke out soon after his emigration he had once more an opportunity of seeing active service. But he had not yet found the proper field for the exercise of his powers. His attempts at farming failed, and his prospects were rather blank, when at last he made the acquaintance of Mr. W. E. Logan, then starting the Geological Survey of Canada. He had had no training in science of any kind, but the mode of life offered by the Survey seemed just what he longed for, and he gladly accepted the proposal that he should join the staff. Before actually beginning his new duties he resolved to do what he could to qualify himself for them. He returned to this country, studied geology theoretically at Edinburgh, and afterwards practically in Wales. In 1843 he went back to Canada and at once began work, remaining at his post for twenty years. He was one of the first and ablest of the stratigraphers with whom Logan traced out the general geological structure of the Dominion. His explorations extended over most of the settled parts and over a large area of forest-land in Western Canada, where he laid down the main lines of structure and the areas of distribution of the rocks. He likewise examined parts of Gaspé and other tracts in the eastern portion of the Dominion. But his most important labours were devoted to the investigation of Newfoundland, of the Geological Survey of which he had charge from 1863 to 1883. From 1866 onwards he prepared an Annual Report of the progress of his work in that colony. These Reports collected by him, and republished as a volume in 1881, contain a summary of all that is known regarding the geological structure of Newfoundland, and will remain as a lasting monument of Mr. Murray's skill as a stratigraphical geologist, and of the courage, patience, aad tact with which he overcame all physical and political difficulties. One of his last labours was the completion and publication of a geological map of the whole of Newfoundland—a work at once beautiful in execution and of the first importance in regard to the industrial growth of the colony. Very few of our colonies yet possess complete geological maps, and hardly ever are they so largely the work of one man as this one. Newfoundland has never adequately recognised how much it stands indebted to Mr. Murray for his share in laying the foundation on which its future development must rest.

SEARLES V. WOOD

AMONG the recent losses which have befallen the geologists of this country not the least is the death of Mr. Searles V. Wood. Himself the son of a geologist, he began his scientific work early in life. He may be said to have been educated upon Tertiary geology, and though at first disposed to wander intc wider fields of

research and speculation, it was in tracing the history of the younger formations that he did his best work and spent the chief part of his scientific career. Since the year 1864 he has been unweariedly engaged in investigating the history of the Pliocene and Post-pliocene deposits of the East of England. Taking up this subject in conjunction with Mr. Harman, he soon became convinced that no satisfactory progress could be made in it until the deposits in question had been actually mapped in some detail. Accordingly the two observers began to trace them on the one-inch Ordnance Map, Mr. Wood taking the southern half of the area, including Essex and nearly the whole of Suffolk. This survey, which for minuteness and accuracy has seldom been equalled by the work of any private workers, remains unpublished, though a reduction of it, on the scale of four miles to an inch, was issued in 1872. Mr. Wood eventually gave up his business, which was that of a solicitor, in order to devote himself with more uninterrupted zeal to the prosecution of his favourite science. The bodily feebleness which debarred him from much active work out of doors seemed only to quicken his energy for literary labours. Some of the best fruits of his life-long devotion were gathered into his two long memoirs on "The Newer Pliocene Period in England," published in 1880 and 1882 by the Geological Society. But his friends anticipated much useful work still to come from one who had pursued his studies with such intelligence and zeal, and who had only reached his prime. In his death, at the age of fifty-four, they mourn one who was ever ready cheerfully and helpfully to impart to others the knowledge he possessed himself, who never hesitated to admit an error when he recognised it, and who leaves behind him a notable example of quiet fortitude and enthusiasm.

A SUNSHINE RECORDER

On June 28 of last year I had the honour of bringing before the Physical Society a preliminary notice of a new sunshine recorder,[1] and as we have now had more than six months' experience of its working, it is possible that some of your readers might be interested in hearing of the results obtained.

The apparatus is of simple construction. It consists of a glass sphere silvered inside and placed before the lens of a camera, the axis of the instrument being placed parallel to the polar axis of the earth. The whole arrangement will be readily understood by an inspection of Fig. 1. The light from the sun is reflected from the globe, and some of it, passing through the lens, forms an image on a piece of prepared paper within the camera. In consequence of the rotation of the earth, the image describes an arc of a circle on the paper, and when the sun is obscured, this arc is necessarily discontinuous. The image is not a point, but a line, and in certain relative positions of the sphere, lens, and paper, the line is radial and very thin, so that the obscuration of the sun for only one minute is indicated by a weakening of the image.

In the actual apparatus the sphere is an ordinary round-bottomed flask about 95 mm. in diameter, and the lens a simple double convex lens of about 90 mm. focal length. The sensitive paper employed is the ordinary ferro-prussiate paper now so much used by engineers for copying tracings. This was selected in consequence of the ease with which the impression is fixed, for the paper merely requires to be washed in a stream of water for six minutes, no chemicals being necessary. When the paper is dry, radial lines containing between them angles of 15° are drawn from the centre of the circular impression, and thus give the hour scale, the time of apparent noon being of course given by a line passing through the plane of the meridian. Fig. 2 is a copy of the record of June 27, 1884; in the morning the sun shone brightly, towards noon clouds began to form, and in the afternoon the sky was hazy. The field in which the instrument is placed is

Fig. 3.

surrounded by trees, so the ends of the trace are cut off sharply by shadows.

With the alteration of declination of the sun, the light

Fig. 2.

entering the camera is reflected from different portions of the sphere, and an alteration of the position of the focus results. This may be corrected in three ways: by moving

[1] *Proc. Phys. Soc.*, vi. 216; *Phil. Mag.*, August 1884, p. 141.

(1) the paper, (2) the lens, or (3) the sphere. In the present apparatus the first method has been adopted, and now the camera is about twice as long as it was in June. As a consequence the circular image is enlarged, and the light therefore weakened, and that at a time of year when it can least be spared. If the focus is altered by moving the lens, the winter circle is small and the summer circle is much larger. This would perhaps be too much to the advantage of the winter sun. If, however, the lens and paper are maintained at a constant distance, and the sphere alone moved, the circles are more nearly of the same diameter throughout the year, the winter one still remaining the smallest. This seems, therefore, to be the most advantageous arrangement, and the one that will be adopted in future. It may be possible also to find positions for the sphere, lens, and paper such that the intensity of the image is a true measure of the intensity of the sun's light; at present, however, this has not been done, the want of sunlight and the press of official work having prevented the carrying out of the necessary experiments. A more sensitive paper might also be used with advantage, and in observatories where photographic processes are carried on daily there would be no difficulty on this score, but my principal object was to devise some economical instrument requiring only easy manipulation, so that at a considerable number of places the instruments might be set up, giving a more useful average of the duration of sunshine than can be obtained from only a few stations. The instrument also gives a record when the sun is shining through light clouds; in this case the image is somewhat blurred and naturally weakened, and it may be difficult or impossible to employ any scale for measuring the intensity under such conditions, but it must be remembered that, even when the sun is shining in this imperfect manner, it is really doing work on the vegetation of the earth, and deserves to be recorded.

It may be well to say that the instrument is in no way protected. Some friends, whose opinion I highly value, urged me to patent it; but as I strongly hold the view that the work of all students of science should be given freely to the world, the apparatus was described at the Physical Society a few hours after the advice was given, lest the greed of filthy lucre should, on further deliberation, cause me to act contrary to my principles.

Cooper's Hill, January 20 HERBERT MCLEOD

NOTES

PROF. PRESTWICH has been elected a Corresponding Member of the Paris Academy of Sciences in the place of the late Italian geologist, Quintino Sella.

SIR WILLIAM THOMSON opened the laboratories at University College, Bangor, on Monday, with an address, in which he referred to the spread of the laboratory system and the good results which thereby had accrued to science and scientific education. We hope in an early number to give a detailed report of Sir William Thomson's address, with a description and plan of the laboratories.

THE honorary degreee of LL.D. has been conferred upon Prof. Ray Lankester by the University of St. Andrew's.

WE understand that Dr. Dallinger, F.R.S., will take the opportunity of his presidential address to the Royal Microscopical Society to give an account of a new septic organism. The address, which will be fully illustrated, will be delivered on Wednesday next at 8 p.m.

THE Paris Academy of Sciences has decided to send a mission to explore the districts in the south of Spain where the recent earthquakes took place. M. Fouqué, Professor of Geology in the Collège de France, is appointed chief of the mission, which was to leave Paris last week. The other members are M. Lévy, mining engineer and sub-director of the geological laboratory of the College of France; M. Bertrand, mining engineer; M. Barrois, of the Faculty of Sciences at Lille; and MM. Killian and Oppret, of the College of France.

AMONGST the honorary members elected to the Italian Society of Geography at its meeting of the 25th ultimo was Mr. Joseph Thomson.

A MEETING of much interest was held at the Rooms of the Asiatic Society on Monday in connection with the establishment of a British School of Archæology at Athens. Already Germany, France, and the United States have been in the field for some time; but though the Greek Government has presented to the English Society a choice site of considerable extent for a school, funds are lacking wherewith to erect the building and carry on the work. We need not insist on the value of archæology in historical research,—all the speakers on Monday were agreed as to that; for a scientific knowledge of the past, it bears the same relation to academical study as the researches carried on by the Naples station do to the home study of biology. At present only 4000*l*. are in the hands of the Committee, but four or five times that amount is required ere the School can start with any hope of efficient work. There are several learned societies with ample means, interested in the varied work which would be carried on by such an institution, and to these, and to individuals who have money to spare and wish to put it to a good use, we commend the scheme. The treasurer is Mr. Walter Leaf, Old Change, E.C.

WE regret to learn of the death of M. Dupuy de Lôme at the age of sixty-eight years. M. de Lôme was well known as a naval engineer, and his name is intimately associated with modern ballooning.

THE Council of the Royal Meteorological Society have arranged to hold, at 25, Great George Street, S.W. (by permission of the President and Council of the Institution of Civil Engineers), on the evenings of March 18 and 19 next, an Exhibition of Sunshine Recorders and Solar and Terrestrial Radiation Instruments. The Exhibition Committee invite the co-operation of those interested, as they are anxious to obtain as large a collection as possible of such instruments. The Committee will also be glad to show any new meteorological apparatus invented or first constructed since last March; as well as photographs and drawings possessing meteorological interest.

IN his inaugural address as Lord Rector at St. Andrew's last week, Lord Reay stated very forcibly his ideas of what a university should be at the present day, encouraging every form of culture and research. Referring to science, Lord Reay asked: "Are we to have a separate Faculty of Science? I should say certainly. Just look at the field covered by a Faculty of Science. It is preparatory for medical science, and our engineers, our manufacturers, our analysts, our botanists, our zoologists, our astronomers, our naval constructors, our geologists, our biologists, our physiologists, our mineralogists, our agriculturists, should obtain scientific degrees. I do not see why a faculty having such an immense area should remain linked with another which has quite different objects to pursue. The same work done by the French École Polytechnique I wish to see done at the universities; and if the Germans have lately spent 340,000*l*. on a new college for technical education at Berlin, I should like to ask what possible reason can be adduced for stinting science-teaching in Scotland at a moment when the report on technical instruction has pointed out that 'theoretical knowledge and scientific training are of pre-eminent importance, as in the case of the manufacturer of fine chemicals, or in that of the metallurgical chemist, or the electrical engineer, and that to these the higher technical instruction may with advantage be extended to the age of twenty and twenty-two.' Here, then, is a clear case even for a

Philistine to grant Government aid. With reference to the science faculty, I should like to make a remark which applies also to the other faculties, but very specially to this faculty. I should wish to give it considerable power to establish lectureships on any special subject for which a specially gifted man should be found. Though the number of his pupils might be very limited, the publication of the results of his research, carried on at the University, would raise it in what I should like to call the international scale. Besides, the knowledge of such prizes being attainable would stimulate original research among the most brilliant undergraduates. I wish those lecturers to be incorporated in the University."

We have received the Report of the Board of Managers of Yale College Observatory for 1883-84. Dr. Elkin is doing good work with the heliometer. The principal lines of investigation to which attention has been directed are as follows :—"(1) The triangulation of the Pleiades. The interest attaching to this work will lie both in the new and independent determination of the relative positions of the stars of this important zodiacal group and in the comparison with the similar determination made with the Königsberg heliometer nearly half a century ago, as well as with the later Paris results. The plan adopted will furnish, it is hoped, trustworthy tests of the reliability of the instrument both for absolute and relative distances and angles of position. From February 24, the date of the arrival of the reversing eye-pieces from Messrs. Repsold, to April 12, after which the stars are lost in the sun's rays, about one-third of the proposed plan has been accomplished. As the group will come into favourable position for observation during the last four months of the year, there is, therefore, all reasonable hope to finish the work during that time. (2) A considerable amount of time has been devoted to the determination of places of the moon relative to stars within measuring-reach of the heliometer. The principal object in view is the determination of the parallactic inequality in the moon's motion, the deduction of which from meridian and other observations is, as is well known, attended with some difficulty. (3) Advantage has been taken of the favourable opportunity afforded by the approaching inferior conjunction of Venus for a series of observations on the diameter of this planet, of which a number have been already secured."

A circular from Mr. H. H. Warner, of the Rochester (U.S.) Astronomical Society, gives the following information as to the Warner Astronomical Prizes :—First. Two hundred dollars for each and every discovery of a new comet made from February 1, 1885, to February 1, 1886, subject to the following conditions :—(1) It must be discovered in the United States, Canada, Mexico, West Indies, South America, Great Britain, and the Australian Continent and Islands, either by the naked eye or telescope, and it must be unexpected, except as to the comet of 1815, which is expected to reappear this year or next. (2) The discoverer must send a prepaid telegram immediately to Dr. Lewis Swift, Director Warner Observatory, Rochester (N.Y.), giving the time of the discovery, the position and direction of motion, with sufficient exactness, if possible, to enable at least one other observer to find it. (3) This intelligence must *not be communicated to any other party or parties*, either by letter, telegraph, or otherwise, until such time as a telegraphic acknowledgment has been received by the discover from Dr. Swift. Great care should be observed regarding this condition, as it is essential to the proper transmission of the discovery, with the name of the discoverer, to the various parts of the world, which will be immediately made by Dr. Swift. Discoverers in Great Britain, the Australian Continent and Islands, West Indies, and South America are absolved from the restrictions in conditions (2) and (3). Second. Mr. Warner will also give a prize of 200 dols. in gold to any person in the world who will write the best 3000-word paper on the cause of the atmospheric effects ("red light," &c.) accompanying sunset and sunrise during the past sixteen months. It is desired that these papers be as original as possible, both in facts, observations, and treatment. Essays must be exclusively sent prepaid to Dr. Lewis Swift, Director Warner Observatory, Rochester, New York, must be written in English, on one side of the paper only, with ink, and must be in the simplest untechnical phrase.

We learn from *Science* that Mr. Henry Lomb, of Rochester, New York, has offered, through the American Public Health Association, the sum of 2800 dols., to be awarded as first and second prizes for papers on the following subjects :—(1) Healthy homes and foods for the working classes : first prize, 500 dols. ; second prize, 200 dols. Essays to be of a practical character, devoid, as far as possible, of scientific terms. They must be within the scope and understanding of all classes, and designed especially for a popular work. (2) The sanitary conditions and necessities of schoolhouses and school-life : first prize, 500 dols. ; second prize, 200 dols. (3) Disinfection and individual prophylaxis against infectious diseases : first prize, 500 dols. ; second prize, 200 dols. (4) The preventable causes of disease, injury, and death, in American manufactories and workshops, and the best means and appliances for preventing and avoiding them : first prize, 500 dols. ; second prize, 200 dols. All essays written for the above prizes must be in the hands of the secretary, Dr. Irving A. Watson, Concord, N.H., on or before October 15, 1885. It is expected that arrangements can be made to have these essays widely distributed to the public, and to the persons mostly interested in the respective subjects in the United States. The American Public Health Association earnestly appeals to those able to compete, to take part in this work, which, it is believed, will do much to augment the health, comfort, and happiness of the people.

We are glad to notice that classes for the instruction and study of elementary astronomy have been established by the Liverpool Astronomical Society, and will meet every Tuesday in the Association Hall, Mount Pleasant. The opening meeting of the class was held on Wednesday, January 21, at—we are informed—twenty o'clock (eight p.m.), when Mr. Isaac Roberts, F.R.A.S., F.G.S., presided and addressed the students. The class throughout the course will be conducted by Mr. James Gill, of the Liverpool School of Navigation.

The distinction of Associate of the Linnean Society has recently been conferred on Mr. James E. Bagnall, of Birmingham. Mr. Bagnall is one of the Vice-Presidents of the Birmingham Natural History and Microscopical Society, of which he has for something like a quarter of a century been one of the most useful and hard-working members. He has devoted his principal attention to the study of botany—structural and systematic. His most important published work is the latest and by far the best "Flora of Warwickshire," which has appeared by instalments extending over several years in the *Midland Naturalist*. This work will, we are informed, shortly appear in a thoroughly revised form as an independent publication. Mr. Bagnall belongs to the class of naturalists of which Thomas Edwards is the type.

At the last meeting of the China Asiatic Society at Shanghai an instrument, which was a species of primitive telephone, was presented for inspection by Dr. Macgowan of Wenchow. It consisted of two bamboo cylinders, from $1\frac{1}{2}$ to 2 inches in diameter, and 4 inches in length ; one end of each was closed by a tympanum of pig-bladder, which was perforated for the transmitting string, the latter being kept in place by being knotted. This rude instrument is called the "listening tubes," and is employed for amusement as a toy, conveying whispers

40 or 50 feet. It is unknown in many parts of China, the provinces of Che-kiang and Kiangsu being the only ones, so far as can be ascertained, where the listening tubes are employed. Besides this toy, Chinese ingenuity produced, about a century and a half ago, the "thousand mile speaker." This implement is described as "a roll of copper, likened to a pipe, containing an artful device; whispered into, and immediately closed, the confined message, however long, may be conveyed to any distance, and thus, in a battle, recent instructions may be conveniently communicated. It is a contrivance of extraordinary merit." The inventor of the "thousand-mile speaker," one Chiang Shun-hsin, of Huichou, flourished during the reign of Kang-hsi, during parts of the seventeenth and eighteenth centuries. He wrote on occult science, astronomy and foreign physics, and the above description of his invention was copied from his works into a provincial encyclopædia. At the time the latter work was published—in the reign of Kien Long—there was no longer an instrument of this kind in the province, as the ingenious invention appears to have perished with the student who contrived it.

THE following very interesting table has been compiled from the records of the meteorological observatory at Tokio. It gives the total number of recorded earthquakes which occurred in the respective months during the ten years ending December 10, 1884:—

January	53	July	36
February	50	August	27
March	73	September	15
April	43	October	47
May	51	November	51
June	40	December	60

The list would, of course, need to be in full detail for each month of each year, in order that any safe deduction might be made from it; but the general notion that there are more earthquakes in winter than in summer receives some support from this table. The average per month for the ten years is 45; that for the six winter months (October–March) is 56; and for the six summer months 35, or about 40 per cent. less. An important element of disturbance in the figures would be the great improvement in seismological instruments since 1874, and the consequent registration of movements which would previously have passed unnoticed.

THERE have been a number of earthquake shocks during the past week. Another severe shock, accompanied by what is described as a tremendous report, occurred at Alhama, on January 27. By the fall of a house one person was killed and two others were injured. On the 27th and 28th fresh shocks occurred in the hot spring district of Southern Styria; also at four o'clock on the morning of the 27th a severe and prolonged shock was felt at Valparaiso. On the 31st a shock occurred at Algiers, destroying eight Arab houses. The shock was also felt at Setif.

MR. JAMES JACKSON, of the Paris Geographical Society, has issued a new and much extended list of various speeds in metres per second. It begins with the Mer de Glace at 0·0000099 m. per second, and concludes with the current from a Leyden jar in a copper wire of 0·0017 m. at 443,500,000 m. per second.

WE are glad to see that the *Health Journal*, the first number of which we noticed, is still continuing to do good work in connection with sanitary science. We have before us the twenty-first number, which contains several useful articles. We commend the *Journal* to the notice of those interested in the subject. It is published by Heywood, of Manchester.

THE *Journal de Saint-Pétersbourg* states that the first Russian school for Mussulmans has been opened at Tashkend. The pupils, who belonged to the families of native notables, numbered forty-one at the commencement. It is proposed to open schools of the same kind elsewhere.

WHEN M. Barral died he had written the larger part of a "Dictionnaire d'Agriculture." The first number, which contains 250 pages large 8vo, two columns, closely printed, has just been published by Hachette and Co. About twelve similar parts will follow in the course of four or five years.

THE additions to the Zoological Society's Gardens during the past week include a Malbrouck Monkey (*Cercopithecus cynosurus* ♂) from West Africa, presented by Mrs. East; a Sambur Deer (*Cervus aristotelis* ♂) from Madras, presented by the Officers 1st Battalion Essex Regiment; a Long-eared Owl (*Asio otus*), a Tawny Owl (*Syrnium aluco*), British, presented by Mr. Geo. E. Crisp; a Malayan Tapir (*Tapirus indicus* ♂) from Malacca, a White Stork (*Ciconia alba*), European, two Magpies (*Pica rustica*), British, deposited; two Calandra Larks (*Melanocorypha calandra*), European, purchased; five Striped Snakes (*Tropidonotus sirtalis*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE OCCULTATION OF ALDEBARAN ON FEBRUARY 22.—In the occultation of Aldebaran on the 22nd of the present month, the immersion takes place while the sun is above the horizon in this country, and the emersion soon after sunset. The following times and angles are founded upon the data of the *Nautical Almanac*, the angles being reckoned as in that work; the times are Greenwich mean times at the respective observatories:—

	Immersion h. m.	Angle from N point °	Emersion h. m.	Angle from N point °
Greenwich	5 16·6	36	5 49·6	344
Oxford	5 13·3	40	5 49 7	341
Cambridge	5 14·9	41	5 52·6	339
Dublin	5 1·8	52	5 50·0	329
Liverpool	5 7·3	49	5 53·3	331
Glasgow	5 3·7	60	5 57·9	320
Edinburgh	5 5·3	59	5 59·3	321

VARIABLE STARS.—Dr. Gould notifies the detection of three new variable stars at Cordoba, which he calls respectively R Lupi, R Piscis Austrini, and R Phœnicis. In his communication to the *Astronomische Nachrichten* he refers to his recently published zones for their positions, which, brought up to the beginning of the present year, will be:—

	R.A. h. m. s.	Decl. ° ′
R Lupi	15 46 1	−35 57·2
R Piscis Austrini	22 11 28	−30 10·7
R Phœnicis	23 50 29	−50 25·6

By Argelander's formula of sines the last maximum of *Mira* should have occurred on January 28, but the maxima and minima of the last four or five years appear to have taken place between a fortnight and three weeks earlier than the dates assigned by the formula. Perhaps some reader of NATURE may be able to fix the time of the recent maximum from his own observations.

WOLF'S COMET.—The following ephemeris of Wolf's comet of short period is deduced from Herr Thraen's ellipse, which depends upon normal places to November 23. The comet was observed without difficulty at Lund on January 20:—

At 6h. Greenwich Mean Time

1885	R.A. h. m. s.	Decl. ° ′	Log. distance from Earth	Log. distance from Sun
Feb. 6	2 10 44	−3 2·7	0·2569	0·2478
7	2 13 8	2 55·6		
8	2 15 31	2 48·6	0·2628	0·2500
9	2 17 55	2 41·5		
10	2 20 18	2 34·4	0·2687	0·2522
11	2 22 41	2 27·2		
12	2 25 4	2 20·0	0·2745	0·2544
13	2 27 26	2 12·8		
14	2 29 48	−2 5·5	0·2803	0·2567

TEMPEL'S COMET, 1867 II.—Reference has been already made in this column to the impossibility of making any reliable prediction of the track of this comet at its approaching return, without a calculation of the perturbations since it was last observed in 1879, owing to its having passed pretty near to the planet Jupiter in 1881. It appears from a communication to the *Astronomische Nachrichten* that M. Raoul Gautier, of Geneva, is engaged upon a determination of the effect of the planet's attraction, and hopes to furnish observers with an ephemeris which may enable them to find the comet without difficulty. M. Gautier states that up to the time of minimum distance of the two bodies (0·55) in October 1881, a retardation of thirty days in the epoch of next perihelion passage had been caused by the planet's action, and it is not to be expected that the comet can arrive at perihelion before the end of June or beginning of July, though without perturbation it would have been due at the beginning of May.

ASTRONOMICAL PHENOMENA FOR THE WEEK 1885, FEBRUARY 8–14

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 8

Sun rises, 7h. 29m.; souths, 12h. 14m. 25·6s.; sets, 17h. 0m.; decl. on meridian, 14° 50′ S.: Sidereal Time at Sunset, 2h. 16m.

Moon (2 days past Last Quarter) rises, 2h. 20m.; souths, 6h. 59m.; sets, 11h. 34m.; decl. on meridian, 16° 44′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on Meridian ° ′
Mercury	6 39	10 45	14 52	21 26 S.
Venus	6 38	10 48	14 58	20 49 S.
Mars	7 36	12 18	17 0	15 39 S.
Jupiter	18 1*	1 6	8 11	11 48 N.
Saturn	11 46	19 49	3 52*	21 33 N.

* Indicates that the rising is that of the preceding, and the setting that of the following nominal day.

Phenomena of Jupiter's Satellites

Feb.	h. m.		Feb.	h. m.	
9	4 27	I. ecl. disap.	11	6 5	II. occ. reap.
	6 59	I. occ. reap.		20 22	I. tr. ing.
	19 53	III. occ. reap.		22 41	I. tr. egr.
10	1 56	I. tr. ing.	12	19 51	I. occ. reap.
	4 16	I. tr. egr.		21 26	II. tr. ing.
	22 55	I. ecl. disap.	13	0 21	II. tr. egr.
11	1 25	I. occ. reap.		5 54	III. tr. ing.
	2 45	II. ecl. disap.	14	19 12	II. occ. reap.

Feb.	h.	
11	12	Mars in conjunction with the Sun.
12	0	Mercury in conjunction with and 0° 44′ south of Venus.
12	9	Mercury at greatest distance from the Sun.
13	10	Venus in conjunction with and 5° 9′ south of the Moon.
13	11	Mercury in conjunction with and 5° 58′ south of the Moon.

Note.—In the two preceding weeks the word *left* in the heading of the last column of the "Occultations" should have been *right.* The angles are understood to apply, as usual, to the inverted image.

GEOGRAPHICAL NOTES

THE Commission which was originally appointed to investigate the possibility of a maritime canal across the isthmus of Krao, in the north of the Malay Peninsula, has continued its exploration in this unknown region. It is composed of M. Delonell, accompanied at first by M. Paul Macey, Mr. Davidson, an English engineer, and a Siamese commissioner. Their second visit to the place was made in the spring and summer of last year. After ascending the peninsula from the isthmus of Krao to 7° 13′ N. latitude, and visiting the Samuil Islands, the most interesting and least known of the archipelagoes in the Gulf of Siam, the expedition penetrated the peninsula to the height of Singora, 7° 14′ N. latitude, where they discovered the existence of a State, Sam-Sam, composed of mestizos, or half-caste Malays and Siamese, the former haunt of pirates and semi-independent of Siam. By wide and deep channels which enter far into the country, the party were conducted to a large inland sea, called Talé-Sab, which they were the first Europeans to visit. This was found to be about 6 metres in depth, and 45 miles long by 12 wide, of a curious configuration, with small islands covered with the nests of sparrows. The water is fresh during the north-east monsoon, but brackish during the south-west; it separates the peninsula properly so-called from the island of Tantalam (or Ko Yai in Siamese) by a number of *arroyos*, which stretch from Singora in the south to Lacon in the north. The party landed at Taloung on the west side, at 7° 40′ N. latitude, where a Sam-Sam rajah supplied them with elephants to cross the peninsula. They crossed a large plain under rice cultivation to the borders of Klong Taloung, then reached the chain of Louang Mountains, which forms the end of the peninsula, and then descended the Tsang River, which flows into the Bay of Bengal. Three visits in all were made to these regions during the year, and the States of Tsang, Taloung, Lacon, Singora, and Stouil were thoroughly explored. The engineers have already made their geological reports of the whole regions, and certain specimens which have been analysed at the School of Mines in Paris shows that deposits of auriferous quartz, tin, and iron exist in this *terra incognita.* Numerous ethnographical observations were also made on the Sam-Sam, their government, and habits of piracy.

MR. A. R. COLQUHOUN has published a notice in the Eastern journals with regard to his projected exploration of the Shan States. His colleague, Mr. Holt Hallett, after consulting with him concerning the further exploration and survey of Siam and the Shan country, has left China for Bangkok, in order there to hold an interview with the King of Siam on the subject. He will thence proceed to Rangoon and Calcutta, to report to, and consult with, the Chief Commissioner of British Burmah and Lord Dufferin. From Calcutta Mr. Hallett will proceed to London to submit his reports to the Royal Geographical Society and the Chambers of Commerce which have supported the exploration survey. Any exploration on the southern frontier of China, such as was intended to be included, is for the present out of the question, owing to the unsettled condition of the frontier regions. The continuation of the explorations in Siam and the Shan country depends on the result of Mr. Hallett's visit to Siam and India. A preliminary report has been drawn up by Messrs. Colquhoun and Hallett, dealing with the first year's operations, which will be published on Mr. Hallett's arrival in England.

AT the meeting of the Geographical Society of Paris on the 23rd ult., M. Mascart president, M. Thouar, known for his journey in search of the remains of the Crevaux expedition, announced that he is about to start on his fourth journey in South America. His project is to ascend the Paraguay, and study the delta of the Pilcomayo, where Crevaux perished, and then to investigate the possibilities of a trade route between Bolivia and the Paraguay. M. Thouar will then carry out the mission with which he is charged by the Bolivian Government—viz. in company with some engineers and naturalists, to study the whole of Bolivia from scientific, industrial, and commercial points of view.—M. Cabres described some episodes of a journey which he recently made to Bokhara; and M. Rey presented to the Society a new map of the north of Syria, designed by M. Thuillier.

UNDER the title of "Un' Estate in Siberia fra Ostiacchi, Samoiedi, Sirieni, Tatari, Kirghisi e Baskiri" (Florence, 1885), Signor Stephen Sommier describes a voyage which he made down the Obi from its confluence with the Irtish to its mouth in the Arctic Ocean. He made during the journey interesting observations on the course of the river, and on the temperature of the water. Towards the end of July the mean temperature was 18° above zero, even at the mouth of the river, and in August it was still + 10°. These have much importance for the question of the navigability of the Kara Sea. Under the influence of these masses of warm water, the coast ice should melt, and consequently the icebergs which have in recent years blocked the straits giving access to the Kara Sea cannot be of great extent. The most important part of the volume, however, is that devoted to the anthropology and ethnography of the Ostiaks and Samoyedes. On the course of the Obi are groups of habitations where travellers are supplied with rowers, and each time Signor Sommier changed his men—about a hundred times in

all—he made anthropological observations, and collected ethnographical objects. These are now in the Ethnographical Museum in Florence, and illustrations of a considerable number of them are found in his work. Besides these tribes, the book also deals with the Bashkirs and Kirghises, whom the author visited in returning to Europe.

THE last *Bulletin* (No. 6) of the Geographical Society of Belgium contains a paper by M. Oscar Royer describing his journey on the Congo; notes on a journey in Texas, by Mr. Lancaster; also "Some words on Atlantis," by M. de Bloek, who regards this fabulous region as merely one of those invented by the ancients for the purpose of working out in imagination their social and political theories. Finally, a study on the first narrative of Columbus, and the old printed editions of it, with a fac-simile of the first "Epistola C. Coloni," printed at Antwerp in 1493.

THE INSTITUTION OF MECHANICAL ENGINEERS

THIS Institution held its annual general meeting in London last week. The list of papers to be read we have already given, though some of them were not read; the only one calling for special notice at our hands is that of Sir Frederick Abel on a "Final Report bearing upon the Question of the Condition in which Carbon exists in Steel." The following are the conclusions which Sir Frederick bases on the present and on the two preceding reports:—

"The results of the experimental work described appear to warrant the following conclusions in regard to characteristics, recognisable by chemical examination, which are exhibited by different portions of one and the same sample of steel presenting marked physical differences consequent upon their exposure to the hardening, annealing, or tempering processes.

(1) In annealed steel the carbon exists entirely, or nearly so, in the form of a carbide of iron, of uniform composition (Fe_3C or a multiple thereof), uniformly diffused through the mass of metallic iron.

"(2) The cold-rolled samples of steel examined were closely similar in this respect to the annealed steel, doubtless because of their having been annealed between the rollings.

"(3) In hardened steel the sudden lowering of the temperature from a high red heat appears to have the effect of preventing or arresting the separation of the carbon, as a definite carbide, from the mass of the iron in which it exists in combination; its condition in the metal being, at any rate mainly, the same as when the steel is in a fused state. The presence of a small and variable proportion of Fe_3C in hardened steel is probably due to the unavoidable and variable extent of imperfection, or want of suddenness, of the hardening operation; so that, in some slight and variable degree, the change due to annealing takes place prior to the fixing of the carbon by the hardening process.

"(4) In tempered steel the condition of the carbon is intermediate between that of hardened and of annealed steel. The maintenance of hardened steel in a moderately heated state causes a gradual separation (within the mass) of the carbide molecules, the extent of which is regulated by the degree of heating, so that the metal gradually approaches in character to the annealed condition: but, even in the best result obtained with blue-tempered steel, that approach, as indicated by the proportion of separated carbide, is not more than about half-way towards the condition of annealed steel.

"(5) The carbide separated by chemical treatment from blue- and straw-tempered steel has the same composition as that obtained from annealed steel.

"It does not appear that this inquiry can be further extended with the prospect of obtaining any additional facts—elucidating the condition of the carbon in steel exhibiting various physical characteristics—the value of which would bear any proportion to the very laborious nature of the necessary experimental work, which has to be conducted with small quantities of material on account of the necessity of carrying out the annealing, hardening, and tempering processes with very thin pieces of steel.

"I believe it will be admitted that, although the data obtained have not led to the discovery of a ready chemical method of differentiating between different degrees of temper in steel (a method of examination which Prof. Hughes's interesting results have almost rendered unnecessary), they have at any rate contributed to the advancement of our knowledge of the nature of steel."

THE INFLUENCE OF DIRECT SUNLIGHT ON VEGETATION

THE influence of direct sunlight on vegetation is generally known, but surely deserves to be a subject of special study. In the following paper we shall only endeavour to describe some facts with relation to this influence. In the first place, the effect of the sun's rays in the tropical regions will be traced, and afterwards in the temperate and arctic zones. The constant high temperature within the tropics is the cause of the plants being less dependent on the direct solar heat than is the case in the greater part of the temperate and cold zones, but, notwitstanding this, there are plants even in the tropical regions requiring for a luxuriant growth the direct rays of the sun.

Of the tropical monocotyledonous plants, the palms are doubtless the most important, and of these the date-palm of the Sahara Desert (*Phœnix dactylifera*, L.) furnishes daily food to the inhabitants of this part of Africa.

It is known that the subterranean wells are the only cause of vegetation in this desert. When a well is discovered, in a short time an oasis arises, and the date-palm appears.

Considering that the first condition for the growth of palms is a humid soil wherein the roots may vegetate, there seems to be at first something strange in the fact of the Great Desert producing species of this family; but the Arabs say that this "Queen of the Oasis" puts her feet in water and her head in the fire of heaven; and this is the cause of the rapid growth of the plant (Greisbach, "Die Vegetation der Erde," Theil ii. p. 87); the water ascends by the roots into the tissue of the tree, and communicates its temperature to the inner parts, so that the influence of the sun's heat is tempered; the evaporation of the plant also causes a lower temperature; thus it withstands a difference of 98° (from 126° to 28°), as occurs in the Desert (Martins, "Le Sahara," *Revue des deux Mondes*, 1864, vol. lii. p. 613).

Though, as we have said above, these plants require, in the first place, water for their roots, the fact of the stems growing in their wild state at a considerable distance the one from the other, and never forming dense forests, proves that they require also the light.

But the date-palm is indigenous to the Great Desert; nowhere else does this plant vegetate so rapidly. When cultivated with success, it is also in a desert-climate, as, for instance, in that of Murcia in Spain (the date forest of Elche), the highlands of Afghanistan, &c. The cause of its culture being without fruits in the Mediterranean is the dry summer, there being no subterranean wells, as is the case in the Sahara.

The sugar-cane (*Saccharum officinarum*, L.) is also a plant requiring the direct solar light; moist climates are disadvantageous to its cultivation. Thus the climate of China, with its heavy rains in May and June (Dove, "Klimatologische Beiträge," vol. i. p. 102), but less precipitation in autumn, when the fruits ripen, is suited for the culture of this plant. It is known that the quantity of sugar depends on the quantity of sunshine.

Turning to the warm temperate zone we see the species of *citrus* cultivated in the sunny climate of Southern Italy, and even by cultivation produce the delicious fruits generally known, because they are in summer under the almost constant influence of the sun's rays in open localities. In the Malayan Peninsula, the supposed native country of these plants, they also grow in open spaces and not in the jungles, requiring a moist soil, but also the solar light, to ripen their fruits; this explains why the finest and largest oranges are obtained when the trees are trained against walls, as is the case in some parts of Southern England.

The vine (*Vitis vinifera*, L.) is also a plant requiring heat in the after summer to ripen its fruits; the climate of Southern France and Italy is therefore well adapted for its cultivation. In the continental climate of Bokhara in Turkestan (40° N. lat.), with its hot summers (in the sandy desert on the Oxus River the soil was found to have a temperature of 144°—Basiner, "Reise durch die Kirgisensteppe nach Chiwa"), the plant is cultivated in the open fields; its winter covering is not taken off before the end of March, but in April the temperature is already very high, and in July it becomes insupportable;[1] the fruit of the vine is ripe by the end of June or the beginning of July. The soil is moistened here by artificial irrigation. A

[1] Mean temperature at Samarkand, lat. 39° 39′, in 1881: April 61°, May 70°, June 77°, July 81°, August 77°, September 68°, and December 28°; mean temperature at 1 p.m. in June 86°, in July 93°, in August 92°, in September 81°.

climate with sudden changes of temperature, as, for instance, in the United States, does not suit this plant. On the banks of the Ohio River the fruits are rotten, or fall down, before they are ripe, notwithstanding that the *mean* temperature of all the months at Cincinnati is higher than at Pesth in Austria; but the American species are cultivated with success.

In California, with its equal temperature, the vine is cultivated, though the *mean* temperature at San Francisco is much lower than in Europe in the same latitude; but the dry Californian summer is not to be found throughout the United States, where heavy rains occur at this season.

Everywhere, in the warm as well as in the temperate regions, corn is cultivated with success where there is in summer direct sunlight enough to ripen its grains: on the highlands of Afghanistan, in China, on the plains of Southern Russia, on the highlands of Mexico, &c.—for these plants require also the direct solar warmth.

On highlands the influence of insolation is very much increased. At Leh, in Tibet, altitude about 12,000 feet, the thermometer rose in July, in the sun, to 144°, and in mid-winter to 84°, though the mean summer temperature is only 61°, and that of the winter 16°.[1] Barley is sown about May 18 and harvested on September 12; but in the valley of Pituk (altitude about 11,000 feet) barley was sown and harvested in two months.

But, in the first place, the solar warmth of the *after*-summer is necessary to ripen the fruits of the most important plants; for the vine a September temperature of at least 59° is thought to be necessary (Greisbach, "Die Vegetation der Erde," theil i. p. 126). Now, if we compare the means of this month of certain places in Southern England (Greenwich 57°, Penzance 57°, Chiswick 57°, Isle of Wight 58°) with others on the Continent (Liege 61°, Mannheim 62°), we see it is clear that the cloudy sky and rain, and not the *mean* temperature, are the causes of the vine being cultivated without success in England.

The limit of corn cultivation ascends on the Continent generally farther to the north than on the shores—Fort Norman (N.W. Territories of Canada) 65°, Jakutsk 62°.

The fact of its reaching 70° N. lat. in Norway (Alten), and the impossibility of agriculture in Greenland, even under 60°, and in Iceland (Reikiavik), notwithstanding the mean summer temperature of Alten and Reikiavik being about equal,[2] can only be explained by the continual clear sky in summer at Alten, and by the powerful insolation here, which is not the case in Iceland. The continual wet climate and absence of sunlight make the grains rot on the stalks before they are ripe (Martins, "Essai sur la Végétation de l'Archipel des Féroé," pp. 388, 392). The period of vegetation at Alten is the same as that in Siberia (Jakutsk), though the mean summer temperature is 9° lower.

But a climate such as that of Northern Norway, where the shores are free of ice even in mid-winter, caused by the north-east branch of the Gulf Stream, is nowhere to be found on the globe under such a high latitude. On the north-east shores of Asia corn cannot be cultivated even under 50° N. lat. The same latitude is its limit on the eastern shores of America; on the western it reaches about 57°. On the north-east shores of Asia the cause is the ice in the sea of Ochotsk, the wind in summer being mostly south-east or south,[3] thus coming from the sea or along the shores, and causing much lower summer temperatures than in the interior,[4] and cloudy sky. On the north-east shores of North America the corn limit reaches 50° N. lat., the cause being here the ice in Hudson Bay and along the shores of Labrador and Newfoundland.[5] But again, it is not alone the low mean temperature which causes the corn limit to descend so far southerly, but want of sunlight.[6]

[1] Frost is observed in September, and lasts till the end of May. See Moorcroft, "Travels in the Himalayan Provinces."

[2] Summer temperature at Alten 53°, at Reikiavik 54°. See Dove, "Temperaturtafeln."

[3] On account of the barometric summer minimum over the Asiatic continent.

[4] Temperature of Ochotsk, lat. 59° 21′: June 46°, July 55°, August 56°, September 47°. Temperature of Nicolajefsk, lat. 53° 8′: June 54°, July 61°, August 61°, September 50°. See Schrenck, "Reise im Amur Lande," bd. iv. p. 405.

[5] Mean temperature in 1876 at York Factory, lat. 57: June 49°, July 57°, August 55°. Mean temperature in 1880 at Moose Fort, Ontario, lat. 51° 16′: June 55°, July 59°, August 55°, September 52°. See *Report* of the Meteorological Service in Canada.

[6] Percentage of sky clouded, Nikolajefsk of the Amur: June 58, July 59, August 63. See Schrenck, "Reise im Amur Lande," bd. iv. p. 476. Percentage of sky clouded in 1880 at Moose Fort: June 66, July 62, August 62. Number of rainy days: June 15, July 15, August 20. See *Report* of the Meteorological Service in Canada.

In the vicinity of the arctic zone the influence of insolation is, in the first place, observed on the Continent. At Turuchansk, lat. 65° 55′, gourds are cultivated, though of a small size (Middendorff, "Sibirische Reise," band iv. theil i. p. 701). The mean temperature in 1881 was: Of June 48°, of July 59°, and of August 55°, the two last months being about equal in temperature to the means of Valentia in Ireland, lat. 51° 55′ (July 59°, August 59°); but at Turuchansk there were, in June, 7 days with the temperature, at 1 p.m., ranging between 68° and 73°; in July, 15 days ranging between 68° and 82°; and in August, 16 days ranging between 62° and 75°. Number of days completely clouded: June 6; July 9; August 3. Snow did occur till June 15, and was observed again on August 29 (*Annalen der Physikalischen Central Observatoriums*, St. Petersburg). In Norway the cultivation of gourds (*Cucurbita Pepo*, L.) reaches 59° 55′.

In North America, at Cumberland House, lat. 53° 57′, a sugar harvest is collected from *Negundo fraxinifolium*, Nutt. (*Acer negundo*, L.), by means of cuttings in the trees, but the flow of the sap is greatly influenced by the action of the sun's rays, and is greatest after a smart night's frost (Richardson, "Search Expedition through Ruperts Land," vol. ii. p. 236).

In summer, the influence of the direct sunlight causes the tropical mid-day temperature so common in the interior of both continents in the temperate zone; but in America the days' differences are much greater than in Asia;[1] even near the eastern shores (Montreal, Quebec, &c.) daily differences of 20° are of common occurrence in midsummer.

The Asiatic continent, reaching to the Arctic Sea, without interruption presents to the sun's rays a much greater surface than is the case with America, where the melting ice in Hudson's Bay and the Arctic Archipelago consumes the greatest part of the solar warmth, being at the same time the cause of the sudden low temperatures occurring when the wind turns to the north or north-west.

Notwithstanding this, the European vegetables and corn are cultivated with success in the United States and the interior of Canada, but some of them cannot stand the sudden changes of temperature, as, for instance, the vine, and also the orange-tree (*Citrus aurantium*, L., et varr.); the general cultivation of the latter does not reach beyond 30° N. lat. (Florida).

Nowhere else is the influence of insolation more distinctly observed than in the arctic regions. It is known that in high latitudes the heat of the sun's rays in summer is often very great. Richardson remarks that (being under about 60° N. lat. near the Slave River) he had never felt the heat within the tropics so oppressive as he experienced it on some occasions in these arctic regions (Richardson, "Search Expedition," vol. i. p. 144), though the sun's rays are here always horizontal instead of vertical, as is the case in the tropical countries. The enormous multitude of mosquitoes suddenly appearing in spring when the ice is thawing, and in places where there is water for their larvæ (swamps, pools, &c.), is also much greater than in India.

The observations on the following page may give some idea of the difference between the temperature in the shade and that in the sun's rays.

At Fort Franklin, Great Bear Lake, North America, lat. 65° 12′, the mean temperature in the last part of March or the beginning of April is about 0° F.; the effect of the sun's rays on the blackened bulb of a thermometer, however, is sufficient to raise the mercury to 90° (Richardson, "Search Expedition," vol. ii. p. 254).

Comparing these observations with those within the tropics we see that the difference between the maximum temperature in the sun in these regions and the northern is relatively small. Maximum temperature in the sun, 1882: Calcutta, 162°; Bombay, 151°; Colombo (Ceylon), 157°; Barbados, 156°. But in dry climates the difference is greater: Melbourne, 169°; Adelaide, 180°. The mean humidity at Adelaide was only 58 per cent.; highest temperature in shade 112°.

Even in the North American Arctic Archipelago, in Smith Sound, lat. 78° 30′, where the mean summer temperature is only 33° (June 30°, July 38°, August 31½°), Kane's observations with the black bulb thermometer gave the following results:—

[1] Greatest difference at Winnipeg, lat. 49° 55′, on July 2, 1881, maximum 98°, minimum 45°; difference 53°. At Poplar Heights, Manitoba, lat. 50° 5′, maximum on May 20, 86°, minimum 27°; thus difference 59°. At Blagoweschtschensk, Siberia, lat. 50° 15′, on May 25, 1881, maximum 79°, minimum 48°; difference 31°. At Akmolinsk, lat. 51° 12′, on May 25, maximum 68°, minimum 50°; difference 18°

From May 16 till September 4 the temperature in the sun's rays was constantly above the freezing-point (with exception of May 22, when this was not the case); on June 15 it reached 48°, on the 26th 54°, on July 5, 70°, and on August 11, 66°.

Observations at Pawlovsk, Russia, Lat. 59° 43' [1]

Date, 1881		Temp. in shade	Temp. in the sun's rays	Difference	Humidity
		°	°	°	%
Feb.	8	2	70	68	75
,,	18	21	88	67	74
,,	21	12	88	76	82
,,	24	12	91	79	76
,,	25	18	97	79	71
,,	28	9	91	82	73
March	14	20	106	86	73
,,	16	27	111	84	66
,,	22	20	109	89	65
May	25	68	128	60	39
June	8	82	140	58	40
,,	29	73	133	60	33
July	2	80	138	58	30
Aug.	10	64	131	67	72
Sept.	8	66	124	58	57
,,	18	62	124	62	66
Oct.	10	52	107	55	63
Nov.	4	32	86	54	78

It is clear that the influence of the sun's rays increases with higher latitude, because the sun in summer rests above the horizon.

Now we come to the main point, viz. the effect of the direct solar heat on vegetation in the northern regions.

In Novaya Zemlya the vegetation (consisting chiefly of herbaceous plants) is, in places exposed to the sun's rays (at the foot of mountains), like an arctic flower-garden, the surface of the soil not being covered with grass as is the case in the temperate regions. The flowers are here of a much greater size than the leaves. In this island, and even in Spitzbergen, the snow disappears in summer by the action of the sun from hills exposed to its light; but on Ben Nevis in Scotland, being a difference in latitude of more than 20°, the snow rests sometimes the whole year.

In the Tundra of Siberia, on the declivities of hills sheltered from the winds and exposed vertically to the sun's rays, the same herbaceous vegetation, with its large, splendid-coloured flowers, is observed (Middendorff, "Sibirische Reise," bd. iv. th. i. p. 733), but this is not the case in plains where the sunlight in its horizontal direction cannot have so much influence on the vegetation of the frozen ground; therefore these plains are in general really deserts, only covered with moss.

Insolation is also the cause of the rich vegetation in some parts of the mountains in the temperate zone (Alps, &c.).

Even in the most northern regions there can be a rich vegetation where the plants in sheltered localities are exposed to the sun. Parry ("Attempt to reach the North Pole") found the scurvy grass (*Cochlearia*) on Walden Island under 80° 30' N. lat. in such a luxuriant growth as he had never seen it before.

Middendorff observed, under 74° 30' N. lat., on the borders of Lake Taimyr in Siberia, on August 2, a temperature of 52° in the shade; but a heliothermometer under glass placed in the sun's rays stood at 104°; an uncovered one marked, in the sun, 70°. The pitch on his boat was not only melted by this temperature, but flowed (Middendorff, "Sib. Reise," p. 657).

But, as is the case also in lower latitudes, the greatest difference between the temperature in the shade and in the sun occurs in early spring. In June, Middendorff was travelling in the Stanowoi Mountains, and saw a rhododendron in full flower; when he was about to gather some flowers of this plant he found not only the roots, but even the stem, frozen hard in the soil. The temperature of the air was between 54° and 43°, but at night it was some degrees below freezing-point.

The assertion of some botanists that the contents of the cells, as soon as they are frozen, make the latter burst, thus causing the death of the plants, has been already refuted by Nägeli; but the important observations of Middendorff have showed clearly that the severest frosts of the Asiatic cold pole, by which the innermost parts of the trees are frozen as hard as iron, have little influence on the tissue when the cold becomes *gradually* more intense; only *when the temperature sinks suddenly below the freezing-point of the mercury* the wood splits with a thundering noise. These crevices have a disadvantageous influence on the vegetation of the tree in summer, because in these places the plant often begins to rot.

[1] *Annalen des Physikalischen Central Observatoriums*, St. Petersburg, 1881.

The trees rest in a frozen state till, in spring, the sun's rays reach the upper parts, and here vegetation is raised, though the roots and lower parts of the stem are still in a frozen state.

But the most interesting discovery on this subject was made by Middendorff under 69° 30' N. lat., on April 14, near the village of Dudino; notwithstanding the clear sky and incessant brilliant light of the sun, the temperature at mid-day ranged from $-4°$ to $-13°$, yet before and after this time from $-24°$ to $-35°$. While going over the glittering snow he was suddenly stopped by the sight of a willow-catkin peeping about an inch out of it. The catkin was wholly developed, yet the branch on which it was observed was, one or two inches down, solidly frozen; this was also the case with the other parts of the plant hidden under the snow (Middendorff, p. 653). Thus this little part of a branch was called to life, for some hours only, by the direct solar rays, in which it was thawed.

In the beginning of August, under lat. 74° 30', Middendorff found the soil exposed to the sun's rays heated to 86°, though the temperature about four inches below the surface was only 39°, and at the depth of about one foot the ground was constantly frozen (Middendorff, p. 666).

It is clear that plants in the high northern regions, when they vegetate, receive more warmth by insolation than is often supposed—1° by the direct solar light itself, and 2° by the heated surface of the ground. The snow and ice being melted by the sun, the necessary water and humid atmosphere never fail; even this is the cause of the luxuriant growth of grass on some places of the Tundra. The flowing water gradually communicates its warmth to the soil, and prevents also the nightly radiation.

All this is proof enough that, when the mean temperature in shade is known, this is not at all sufficient for a knowledge of the real temperature by which the vegetation of several plants is raised. What might have been the temperature in the tissue of the little branch and also in that of the willow-catkin, of which we have spoken? and this when the temperature in the shade was so many degrees below freezing-point.

In the temperate regions vegetation commences in spring, when the difference of temperature between night and day is greatest; in the high north this difference is often insignificant, because the sun rests above the horizon; but the temperature of the soil being at this time very much lower than that of the objects exposed to the sun's rays, even this great difference is the cause of the very rapid vegetation in sheltered localities and under the influence of the solar light.[1]

In conclusion we must remark that the facts thus briefly mentioned show how much a new system of bio-meteorological observations is wanted to ascertain the real quantity of warmth and sunlight necessary for the growth of plants, many of which are of the utmost importance in the life of man.

M. Buysman

NEW ORGANIC SPECTRA [2]

THE absorption-spectra to be described were detected by means of the microspectroscope, and most of them are only fully visible in it, as the dispersion of the chemical spectroscope is too great for the detection of some of the very feeble bands. A binocular microscope provided with a substage achromatic condenser, to which are fitted two diaphragms, was specially made for this kind of work. Its objectives are so adapted as to enable both fields to be fully illuminated when any power up to the one-eighth is used. The left-hand tube is used as a "finder," and as a means of getting any required portion of the object into the centre of the field so that its spectrum may be obtained in the spectrum eyepiece of the right-hand tube. In this way the various portions of a very small bit of tissue or organ may be readily differentiated from each other and

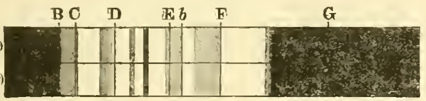
[1] In 50° N. lat., on the banks of the Amur River, where the situation with regard to the ground-ice in spring is the same as in the Taimyr country, *Nasturtium* and *Calamagrostis* plants were observed to grow about half a foot every day (see *Beiträge zur Kenntniss des Russischen Reiches*, Band xxiii. pp. 547, 617.

[2] Abstract of a communication made to the Physiological Society, at the meeting on December 13, 1884 (and published in *Proceedings* No. iv. 1884), by Dr. C. A. MacMunn

their spectra observed. Moreover, by the use of the iris diaphragm, which is placed below the substage condenser, the marginal part of the field can be readily cut off. Another piece of apparatus is indispensable, namely, the *compressorium*, as by its aid the section is squeezed out thin enough to allow the spectrum to be observed.

No reagent whatever is required for the detection of the spectra to be described, so that the substances present cannot be altered in any way.

Myohæmatin.—Physiologists have accepted Kühne's statement that muscle owes its colour to hæmoglobin, but although the majority of voluntary muscles do owe their colour to it, it is accompanied by myohæmatin in most cases, and sometimes entirely replaced by it, while in other cases it entirely replaces myohæmatin. The *heart* muscle of every vertebrate animal which I have examined yields myohæmatin, which gives a very beautifully defined spectrum totally distinct from any decomposition product of hæmoglobin, *e.g.* methæmoglobin, acid or alkaline hæmatin, or hæmatoporphyrin. All one has to do in order to detect myohæmatin is to cut off a bit of heart muscle, put it while fresh in the compressorium, press it down, and observe the spectrum. *No reagent whatever is required.* The spectrum consists of three bands, two of which are very narrow, and persist after the hæmoglobin bands have gone when the tissue has been squeezed out to great thinness in the compressorium. The bands have been missed by other observers simply because when the oxyhæmoglobin bands are well marked they cover and are merged into the myohæmatin bands. The first band of myohæmatin occurs just before D, the next two (of great narrowness) are placed between D and E, and two other faint bands may be present nearer violet, of which the first covers E and *b*, and the other is between *b* and F, close to latter line. Their wave-lengths are: 1st band λ 613–596·5, 2nd band λ 569–563, 3rd band λ 556–549 (heart of dog), and they have been measured in all cases with the same result. I find myohæmatin in the heart muscles and some voluntary muscles of the following



1.—Myohæmatics from Alar muscles of *Vespa vulgaris*. 2.—Myohæmatics from heart of *Limax variegatus*.

mammals:—Man, dog, cat, rabbit, guinea-pig, hedgehog, sheep, ox, pig, rat and hare. In birds: in pigeon, owl, duck, goose, turkey, and fowl. In reptiles: in green lizard, common ringed snake, and fresh-water tortoise. In Batrachians: in toad, frog, salamander, axolotl, and tree-frog. In fishes: in herring, mackerel, tench, roach, eel, plaice, whiting, and cod-fish.[1] But it is also found in Invertebrates, in which I first detected it. It is found in the muscle from thorax and in leg muscles of the following insect genera:—Dytiscus, Hydrophilus, Lucanus, Cerambyx, Creophilus, Staphylinus, Geotrupes, Carabus, Coccinella, Musca (three species), Tipula, Gryllus, Blatta, Vespa, Apis, Bombus, Pieris, Ennomos, &c. It also occurs in the cephalo-thoracic muscles of spiders, in the heart of the crab, lobster, and crayfish (and not in their voluntary muscles); in the heart and buccal muscles of Arion, Limax, Helix, and other pulmonate mollusks, while in other mollusks it appears to be replaced by hæmoglobin in the pharyngeal muscle, as Prof. Lankester has found out

Two attempts have been made to isolate it. In the first it was got out of the muscle by digesting in pepsine solution, and was slightly changed in the process; in the second it was got out of the frozen heart muscle of a rabbit by pressing out the plasma;[2] here it was mixed with traces of hæmoglobin, but could be differentiated from it: hence it probably occurs in muscle *plasma* like muscle-hæmoglobin.

Histohæmatin.—This name has been given by me to a class of pigments or modifications of the same pigment, which are found widely distributed in the animal kingdom. Myohæmatin belongs to them, as can easily be shown. They are found in Mollusks, Arthropods, Echinoderms, and, modified peculiarly, in Cœlenterates. The bands are carefully measured and compared

[1] These being all the vertebrate animals which I have yet examined.

[2] After suitable precautions had been taken to exclude the influence of the blood, as fully described in the demonstration.

with spectra yielded by various organs and tissues of Vertebrates, and no difference is found between those of Vertebrates and Invertebrates. In order to see these spectra in the higher animals the blood-vessels are washed out with salt solution thoroughly, and then the organs and tissues examined in the manner described. It is not possible to go into this subject in an abstract, as the facts are too numerous to be compressed into such a small space; it will suffice to say that the histohæmatins are respiratory pigments, as can be proved by oxidising and reducing them in the solid organs. Their bands occupy almost the same place as those of myohæmatin, except that the second and third bands of the myohæmatin spectrum appear compressed into one in some cases.

Myohæmatin itself is also undoubtedly a respiratory substance.

Spectrum of the Supra-renal Bodies.—In the supra-renals of man, cat, dog, guinea-pig, rabbit, ox, sheep, pig, and rat, the medulla gives the spectrum of hæmochromogen, while the cortex shows that of a histohæmatin. Wherever we find hæmochromogen in a vertebrate body it is probably excretory, and I have only found it in the bile and in the liver. Hence, and owing to the remarkable darkness of its bands in the medulla of the adrenals, it must be looked upon here as excretory; if so, the function of the adrenals must be (at least in part) to metamorphose effete hæmoglobin or hæmatin into hæmochromogen; if from disease, or after removal, as in Tizzoni's experiments, the effete pigment is not removed, pigmentation of skin and mucous membrane may take place. The presence of taurocholic acid in the medulla (Vulpian), the resemblance in the structure of the adrenals to that of the liver, and the large lymphatics, with the well-known results of disease of the adrenals in Addison's disease, all go to show that an active metabolic process is taking place in them, and I believe I am justified in concluding that they have a large share in the downward metamorphosis of effete colouring matter, and that these observations will help to throw some light on Addison's disease.

SOUTH GEORGIA

SOME interesting particulars of the geography, climate, &c., of the island of South Georgia have recently been published by the members of the German Expedition which sojourned in 1883 at the island. They are of the more interest as no scientific expedition had previously visited the island, of which but little therefore is known. The Expedition, in command of Dr. Schrader, took up their quarters at Moltke Hafen, in Royal Bay, which is from four and a half to five miles wide and from six to eight miles long; here observations were made from September 15, 1882, until September 3, 1883, when the Expedition left in a German gunboat. The 8472 observations made during this period on the temperature, air-pressure, moisture, wind, &c., are of great importance.

The island is by its position (54° 31′ S. lat. and 36° 5′ W. long.) not an Antarctic island in the strict sense of the word, but its appearance stamps it as such—Royal Bay being surrounded by mountains, with enormous glaciers from 900 to 1200 feet in height, which further inland rise to 6000 or 7000 feet. This circumstance may give some idea of the climate, and it is therefore not surprising to learn that the mean temperature of the whole period of observation was only 35° F.; for February, the warmest month, 42°, and for the coldest (June) 26°·6. No single month was free from frost, and 30 per cent. of the hours of observation showed a temperature below freezing-point. In July the minimum-thermometer registered 26°·2, and in February the maximum-thermometer 57°·2, the range of temperature amounting to 31°. Clear days occurred in the winter only, the total number being 8; whereas the total of cloudy days was 127; the latter were less frequent in July and August. During December not a single day was clear, and the total number of hours of clear sky was only 269, against 3302 which were cloudy, viz. 38·9 per cent. of the total. Consequently there was much rain and snow, particularly in November and December, which had only one dry day each. Most snow fell in March and least in May. Even the warmest month, February, had 13 days with snow, while the coldest, June, had four days with rain. It hailed on 19 days, principally in December; there were 75 days of fog, but it did not last long. As regards winds and storms, the observations of the Expedition seem to indicate that the neighbourhood of Cape Horn is not quite so stormy as is generally believed. At South Georgia there were

many days of perfect calm; the summer was, however, more stormy than the winter. The winds came chiefly from the west—those from a due westerly direction being most common—and also from west-south-west or north-west. The westerly and south-westerly winds were during the winter the warmest, which is ascribed to the circumstance that they passed over mountains some 6000 feet in height, which rendered them "Föhn-like." The barometer readings were never attended by violent storms; these occurred without exception when the glass stood at "fair." There was no aurora australis, nor were there any thunderstorms.

Explorations of the island were undertaken on several occasions, and many of the peaks in the neighbourhood of Royal Bay were climbed. The slate rocks were very difficult of ascent. The enormous glaciers in the mountains of the interior prevented, unfortunately, any thorough exploration of this part. The mountains often sloped abruptly into the sea, and the highest points were about ten miles from the station and covered with eternal snow. The roar of avalanches was continually heard. The fauna was very poor. That such a dreary climate should boast of a very extensive fauna or flora was hardly to be expected; nevertheless, the mosses were very fine. Dr. H. Will, the botanist, collected about thirty varieties. They show what a climate where the sun is nearly always absent can produce in the way of plants which are able to resist rapid changes of temperature, but the fauna is one which may at once be said to belong to more Antarctic regions than Terra del Fuego, the Kerguelen Islands, and more northerly places. It is a repetition of the same types, with originality in details alone.

CARTOGRAPHICAL WORK IN RUSSIA

WE learn from a recent issue of the *Izvestia* of the Russian Geographical Society that the following geodetical and cartographical work was done during the year 1883 by the officers of the Russian General Staff. The first-class triangulation for connecting the line of Warsaw and Grodno with that of the Vistula was continued; the secondary network of triangulation was extended in Lithuania and Poland; and the heights of 262 places were determined by careful levellings. The most useful work of exact levellings on the Russian railways, undertaken several years since, was continued in West and South-West Russia, leading to a precise measurement of the differences of level between the Baltic and the Black Seas, and the final results are now being calculated. The Russian survey was continued on the scales of 1400 and 1750 feet to an inch, in Poland, Lithuania, Bessarabia, and Finland; and a most welcome feature of it is that great attention was given to the measurements of heights, so that a map with level-lines only, 35 to 70 feet apart from one another, may be published. In the Caucasus very accurate measurements of the latitudes and longitudes of Tiflis, Baku, and Shemakla were made, as also pendulum observations in Trans-Caucasia. Of trigonometrical measurements, the triangulation of the Trans-Caspian region was continued as far as the Persian frontier, and that of Akhal-Tekke, was also calculated. An interesting feature of this last was the measurement of two geodetical bases on strings—which method gives, as is known, very satisfactory results—together with a much greater economy of time. Detailed surveys were continued in several parts of the Caucasus, those at Askabad, and between Kyzil-Arvat, Bami, and the Sumbar River (two versts to an inch) being especially worthy of notice.

In Turkestan, at the Tashkend Observatory, Col. Pomerantseff continued his observations of minor planets with the refractor of the Observatory, and the measurement of stars by means of the meridian-circle; and his assistant, Capt. Zalessky, regularly made measurements of occultations of stars by the moon. The work of the Observatory will soon be published, and will contain an elaborate paper by Dr. Schwartz, on magnetism in Turkestan. Several most valuable determinations of latitudes and longitudes were made by M. Putyata in the Pamir during M. Ivanoff's expedition. Among many surveys which were made this year, that of the northern slope of the Turkestan ridge was especially interesting, no less than twenty-three unknown glaciers having been discovered at the sources of the Sokh, and mapped. The Shemanovsky glacier, eight miles long, and that of Ak-terek, twenty-two miles long, which joins the well-known Zarafshan glacier, are especially worthy of notice. A survey of the rich oasis of Karshi, and of the Bokhara dominions on the right bank of the Zarafshan, is also very interesting. The map of Turkestan on the scale of ten versts (seven miles) to an inch, is already in print, and several sheets are nearly ready.

In the Omsk military district we notice several determinations of latitudes and longitudes, as also the survey of the Kirghiz Steppe, on a scale of five versts to an inch. In Eastern Siberia the chief work was the further extension of the triangulation of Trans-Baikalia—a most necessary work, on account of the scarcity of determined points to fix the surveys in that region—and many local surveys, those in the Ussuri region and on the Pacific coast being especially interesting. The astronomically determined points, very few on the whole, have received only seven additions.

The Hydrographical Department has pursued its work on the Baltic, the Black, and the Caspian Seas, as also on some lakes in the interior of Russia and Finland; the most interesting of them being several detailed maps of the Lake of Onega, and the Lakes Päyänne and Pielis, in Finland; the triangulation and surveys on the Caucasian coast of the Black Sea; and the survey of the Gulf Mortvyi Kultuk of the Caspian.

Among the publications of the General Staff we notice the thirty-ninth volume of its *Memoirs*, which contains the following papers:—On the triangulation of Bessarabia, by Col. Lebedeff; on the difference between the longitudes of Tashkend and Vernyi, by Col. Pomerantseff; on astronomical determinations made in Trans-Baikalia (fifty-two places), by Capt. Polanovsky; in the Altay region and in West Siberia (thirteen places), by Col. Miroshnitchenko; in the Trans-Caspian region (with a map), by Col. Gladysheff; and in North-West Mongolia, by Lieut. Rafailoff; on levellings on Russian railways; on the determination of time by means of the meridian-circle, by M. Gladysheff; on the Trans-Caspian triangulation (ninety-two places), by Capt. Pervas, in which it is stated that Askabad is 827 feet, and Mount Riza, on the Persian frontier, 9741 feet, above the sea-level; and finally, a description by Col. Alexandroff of the route from Kungrad to the Gulf of Mortvyi Kultuk, the distance being 300 miles, of which about 90 miles are without water.

The Annual Report of the Hydrographical Department contains seven small maps showing the exact results of the surveys made on the Russian coasts up to 1882; and a paper by M. Goloviznin gives at the same time a sketch of the hydrographical work done by the Russian fleet since its first formation in 1696.

SCIENTIFIC SERIALS

IN the *Journal of Botany* for January Mr. H. N. Ridley describes and figures the extremely rare *Juncus tenuis*, a plant entirely lost to Britain since 1795 or 1796, when it was gathered by G. Don in Clova, till 1883, when it was rediscovered by Mr. Towndrow in Herefordshire. Mr. W. H. Beeby records another interesting addition to the British flora in a new *Sparganium*, which he names *S. neglectum*, nearly allied to *S. ramosum*, and probably a sub-species of it, found in ponds in several parts of Surrey.

THE last part of the *Belgique Horticole* that has reached us, that for May and June 1884, contains but little that is original, the substantial articles being taken from French, German, or English journals. The coloured plates of new or little-known plants, with accompanying descriptions, are of their usual excellence, and there are many short paragraphs of interest to horticulturists.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 29.—"On some Physical Properties of Ice and on the Motion of Glaciers, with special reference to the late Canon Moseley's Objections to Gravitation Theories." By Coutts Trotter, M.A., Fellow of Trinity College, Cambridge. Communicated by Prof. Stokes, Sec. R.S.

Canon Moseley's theory of glacier motion, put forward in 1855, has never been accepted by persons conversant with glaciers. In 1869, however, he put forward a somewhat formidable objection to the current gravitation theories of glacier motion.

The gist of the objection is that the resistance of ice to shearing is many times greater than the shearing force which can be produced in a descending glacier by gravity; and that therefore the shearing which the measurements of Forbes and

others have shown to be an essential part of the motion of a glacier cannot be produced by gravity alone.

It was pointed out at the time that in Moseley's experiments on the shearing strength of ice the element of time had been disregarded, and a number of experiments have been since published, chiefly on the bending of pieces of ice under the influence of their own weight, which showed conclusively that the continuous action for a considerable time of comparatively small forces will produce effects upon ice which the same forces are quite incapable of producing in a short time. The nature and conditions of the motion were, however, very different from those which we meet with in a glacier.

Under these circumstances it seemed desirable that fresh direct experiments on the shearing strength of ice should be made under conditions differing as little as might be from those under which ice actually shears in the interior of a glacier, and it occurred to me that such experiments might be advantageously made in one of the artificial grottoes which are now excavated year after year for the benefit of tourists in several of the more accessible Swiss glaciers. It seemed that it would be possible in this way to carry out experiments upon glacier ice at a nearly uniform temperature of about 0° C., and under conditions as nearly resembling those of the interior of a glacier as we can hope to attain to in experiments on hand specimens of ice.

I accordingly spent part of the long vacation of 1883 at Grindelwald, and made a series of experiments in the grotto on the right bank of the lower glacier, in order to see whether I could obtain direct evidence of shearing under the influence of forces comparable with those which Canon Moseley admits to be capable of being produced by the action of gravity in a moving glacier.

The experiments are fully described in the paper. Bars of ice were passed through holes in three parallel blocks of wood, nearly in contact with one another. The two outer blocks were hung to a frame and a weight was suspended from the middle one. After the whole had hung for some days, the apparatus was taken to pieces and the shear measured. In a final experiment a shear of about ·075 cm. was observed after the action for about seventeen days of a shearing force of rather more than 200 grm. per square centimetre.

The shearing force employed was indeed rather more than double that which, according to Canon Moseley's calculations, is exerted by gravity in the Mer de Glace, near the Tacul (*Phil. Mag.* xxxvii. p. 369); but it is aboat 1/25th of his smallest value of the shearing strength of ice, and the amount of shear is larger than is implied in any of the ordinary cases of glacier motion.

I think then that there is little doubt that under conditions closely resembling those of the interior of a glacier, and under the influence of forces comparable with those which gravity is capable of exerting in a glacier, hand specimens of ice shear in the same manner as a truly viscous solid would do.

Reasons are given for supposing that the range of temperature through which ice is sensibly viscous is small; the temperature of the interior of a glacier is discussed, and it is pointed out that the position of the "Bergschrund" so familiar in Alpine literature corresponds to a point where there is a change in the temperature of the lower part of the glacier, all below the "Bergschrund" being soft and viscous, all above it hard frozen and immovable.

The general result of the foregoing paper seems to be that the fuller consideration of the physical properties of glacier ice leads to essentially the same conclusions as those to which Forbes was led forty years ago by the study of the larger phenomena of glacier motion—that is, that the motion is that of a slightly viscous mass partly sliding upon its bed, partly shearing upon itself under the influence of gravity. To say this is, however, by no means to deny the importance of regelation in the economy of a glacier. To regelation mainly we must attribute the gradual passage of snow through the form of *névé* into ice, the healing of crevasses, and the possibility of comparatively rapid and violent changes of form in portions of a glacier in which unusually powerful forces may be supposed to be at work. Moseley's argument, however, seems to be decisive against the belief that the ordinary comparatively undisturbed descent of a glacier along a moderately sloping bed takes place by fracture and regelation. Moseley's value of the shearing strength of ice, which has been shown to be enormously too great as a measure of the resistance of ice to slow shearing, would appear on the other hand to be an inferior limit to the resistance to the shearing fracture which must precede regelation.

Royal Society, January 29.—"On the Structure and Rhythm of the Heart in Fishes, with especial reference to the Heart of the Eel." By J. A. McWilliam, M.D., Demonstrator of Physiology in University College, London. (From the Physiological Laboratory, University College.) Presented by E. A. Schafer, F.R.S.

The eel's heart presents some peculiarities in structure. The auricle and ventricle are separated by a canalis auricularis. The ventral wall of the sinus venosus does not end in the proper auricular tissue but passes on to be attached directly to the ventricle. The superficial part of the ventricular wall is supplied by a special system of blood-vessels.

When the ventricle is faradised, it is found that a slowly-interrupted current (*e.g.* 3 per second) has a much more powerfully stimulating effect than a rapidly-interrupted current (*e.g.* 50 per second) of precisely the same strength.

The inhibitory effects of stimulation of the vagus nerve-trunk are very powerful; the accelerating after-effects are slight and variable. Vagus stimulation exerts no *direct* influence on the ventricle; it profoundly affects the auricle and sinus. It temporarily abolishes the excitability of the auricular muscle and of the muscular tissue entering into the composition of the ostial part of the sinus.

The manner in which the heart's action recommences after vagal inhibition is peculiar; the interjugular part of the sinus and the ventricle beat before the auricle and the ostial part of the sinus begin.

The passage of a weak interrupted current through any part of the auricle causes that part to stand still while the rest of the auricle goes on beating. Curara obviates the occurrence of this localised inhibition.

Physical Society, January 24.—Prof. Guthrie, President, in the chair.—Messrs. J. Rose Innes, A. Howard, and A. M. Worthington were elected members of the Society.—Some lecture experiments on spectrum analysis were shown by Mr. E. Clemenshaw. The chief point in these experiments was the production of a brilliant light without the use of the electric arc. A small quantity of a solution of the salt to be experimented on is put into a flask in which hydrogen is being evolved by the action of zinc upon dilute sulphuric or hydrochloric acid; the bottle is provided with three necks, one being fitted with an acid funnel, one with a jet, and by the other is introduced a current of coal-gas, or better, of hydrogen, by which the size of the flame can be increased and regulated. The jet, which is about one-eighth of an inch diameter, is surrounded by a larger tube, by which oxygen is admitted to the flame, the result being a brilliant light giving the spectrum of the substance, which is carried over mechanically by evolved hydrogen. The spectra of sodium, lithium, and strontium were shown upon the screen, and the absorption of the sodium light by a Bunsen flame containing sodium was clearly seen.—An instrument to illustrate the conditions of equilibrium of three forces acting at a point was exhibited by Mr. Walter Baily. This instrument consists of a circular disk of soft wood from the back of which an axle projects. The disk is provided with a graduated circle, and its centre marked by the intersection of two fine lines upon a small mirror. Three compound threads, each consisting of two threads connected by a short piece of elastic, are knotted together, the free end of each being fastened to a pin. Two of these pins are stuck into the disk at such a distance from the centre that the knotted ends cannot reach the centre without stretching each thread, and the remaining pin is then adjusted so that this condition is fulfilled. There are now three forces in equilibrium acting at the knot. The angles between their directions are obtained from the readings of the graduated circle where it is crossed by the threads. To determine the magnitude of these forces, the axle of the disk is held horizontally and turned till a thread is vertical; the pin is then removed, a scale-pan attached to the end of the thread, and weights added till the knot is brought back to the centre. This is repeated with the other threads. It was found possible to show the proportionality of the forces to the sines of the opposite angles with an error not exceeding 1 per cent.—Mr. C. H. Hinton read a paper on the "Poiograph." As the result of a process of metaphysical reasoning, Mr. Hinton has come to the conclusion that relations holding about "number" should be extended to space. Starting from the premiss that the relation of a number to a number is a number, *e.g.* the "relation" of 6 to 2 is 3, the author proceeds to carry these principles into the consideration of space, and concludes that, when properly understood, the relation of a

shape to a shape is a shape, and that of a space to a space is a space. The shape that shows the relation of a shape to a shape is called a "poiograph." To form a poiograph the content of each shape is neglected, and the shape is represented by a point, each point being by its coordinates representative of the properties of the shape considered. The resultant shape is a "poiograph."

Anthropological Institute, January 27.—Anniversary meeting.—The retiring President, Prof. Flower, LL.D., F.R.S., in his anniversary address, gave an outline of the classification of the varieties of the human species which appeared to him to be most in accordance with the present state of knowledge on the subject, but which, he remarked, differed in its main outlines but little from that adopted by Cuvier sixty years ago. It was first stated that there were three extreme types, those called by Blumenbach Ethiopian, Mongolian, and Caucasian, around which all existing individuals of the species could be ranged, but between which every possible intermediate form could be found. The distinctive characters of each of these extreme types were described and their subdivisions pointed out. The Ethiopian or Negro branch was divided into (1) African Negroes; (2) Hottentots and Bushmen; (3) Oceanic Negroes or Melanesians; (4) Negritos, of which the natives of the Andaman Islands are representatives. It was suggested that the Australians, who have always presented a difficulty in classification of the races of men, owing to the combination of negroid characters of face and skeleton, with hair of a different type from that of the rest of the group, were probably not a pure race, but descendants of a cross between an original Melanesian population and later intruders, probably from the South of India, and of Caucasian descent. The Mongolian type was represented in an exaggerated form by the Eskimo, in a typical condition by the greater number of the inhabitants of Northern and Eastern Asia, the Tartars, Chinese, Japanese, &c., and in a modified or sub-typical form by the Malays. The brown Polynesians were still further modifications of the same type, greatly mixed with Melanesian and possibly also Caucasian blood. The position of the native races of America was next discussed. Excluding the Eskimo, they all form one group, which, although inclining on the whole nearer to the Mongolian than any of the three great types, had so many special features that it might be looked upon as forming a fourth primary division. The Caucasian, or white branch, includes two sub-races now much mingled together, the Xanthochroi, with fair hair and eyes, and the Melanochroi, with dark hair, eyes, and complexion. To the former belong the inhabitants of Northern Europe, to the latter chiefly those of Southern Europe, Northern Africa (greatly mixed in varied proportions along their frontier line with Negroes), and South-West Asia, the principal sub-divisions being the Aryans, Semites, and Hamites. The address concluded by a reference to two members of the Council lately deceased, Dr. Allen Thomson and Mr. Alfred Tylor; to the change of locality of the meetings which had taken place during the year from St. Martin's Place to Hanover Square, and to other matters relating to the affairs of the Institute. The election of W. Pengelly, F.R.S., was announced. The following gentlemen were elected officers and Council for the year 1885:—President: Francis Galton, M.A., F.R.S.; Vice-Presidents: Hyde Clarke, John Evans, F.R.S., Prof. W. H. Flower, F.R.S., Lieut.-Col. H. H. Godwin-Austen, F.R.S., Major-Gen. Pitt-Rivers, F.R.S., E. B. Tylor, F.R.S.; Director: F. W. Rudler, F.G.S.; Treasurer: F. G. H. Price, F.S.A.; Council: S. E. B. Bouverie-Pusey, E. W. Brabrook, F.S.A., C. H. E. Carmichael, M.A., W. L. Distant, A. W. Franks, F.R.S., J. G. Garson, M.D., Prof. Huxley, F.R.S., Prof. A. H. Keane, B.A., A. L. Lewis, Sir J. Lubbock, Bart., M.P., R. Biddulph Martin, M.P., Prof. A. Macalister, F.R.S., J. E. Price, F.S.A., Charles H. Read, F.S.A., Charles Roberts, F.R.C,S., Lord Arthur Russell, M.P., W. G. Smith, F.L.S., Prof. G. D. Thane, C. Staniland Wake, M. J. Walhouse, F.R.A.S.—It was announced that at the next meeting of the Institute, on February 10, a paper would be read by Mr. H. H. Johnston, on the tribes of East Equatorial Africa.

Entomological Society, January 21.—Anniverary Meeting.—J. W. Dunning, M.A., F.L.S., President, in the chair.—An abstract of the Treasurer's accounts was read by Mr. H. T. Stainton, F.R.S. (one of the Auditors); and the Secretary read the Report of the Council.—The following gentlemen were then elected as the Council for 1885:—President: R. McLachlan, F.R.S.; Treasurer: E. Saunders, F.L.S.; Secretaries: E. A. Fitch, F.L.S., and W. F. Kirby; Librarian: F. Grut, F.L.S.; other Members of Council: T. R. Billups, J. W. Dunning, R. Meldola, J. W. Slater, H. Druce, H. Goss, S. Stevens, and J. Jenner Weir.—The retiring President then delivered an address, and a vote of thanks was moved to him by Mr. Stainton and seconded by Mr. J. W. May, and Mr. Dunning replied.—A vote of thanks to the officers was then moved by Mr. McLachlan and seconded by Mr. Waterhouse, and Messrs. Saunders, Fitch, Kirby, and Grut replied.

Victoria Institute, February 2.—A paper on the origin of savage nations by degradation was read by Mr. F. A. Allen, in which he said he only desired to suggest that this was not an unreasonable assumption, and he proceeded to show that traces of a high degree of civilisation either recorded by history or tradition existed amongst many of those peoples which were now generally regarded as savages.

Edinburgh

Royal Society, January 19.—A. Forbes Irvine, Vice-President, in the chair.—Mr. J. B. Readman gave a paper on the ores of nickel and cobalt of New Caledonia. These ores have only recently been identified, although they are met with in great abundance.—Prof. Tait called attention to the expressions used by Newton in the scholium to his "Laws of Motion" when speaking of Mariotte, as contrasted with the expressions he used when speaking of Wren and Huyghens.—Prof. R. Smith communicated a paper on the graphic analysis of the kinematics of rigid-bar mechanisms.—Prof. Tait gave a communication on the necessity for a condensation nucleus. This involves a modification of Prof J. Thomson's hypothetical form of the isothermals of a true vapour. In the modified form the isothermal shows at once the necessity for the condensation nucleus.

Royal Physical Society, January 21.—John A. Harvie-Brown, F.R.S.E., F.Z.S., &c., President, in the chair.—The following communications were read:—On the ova and the ovary of Echidna, by F. E. Beddard, M.A.Oxon, F.R.S.E., F.Z.S.—Investigations on the movements and food of the herring, with additions to the marine fauna of the Shetland Islands, by Fred. G. Pearcey.—Notes on the birds of the Island of Eigg, by William Evans, F.R.S.E.—Mr. B. W. Peach, F.R.S.E., &c., read a paper by Mr. Robert Ridston, F.G.S., on impressions of rain-drops, recent and fossil, with exhibition of specimens.—Mr. J. A. Harvie-Brown, F.Z.S., &c., exhibited, with remarks, a specimen of *Larus Kumlieni*, from Cumberland Inlet; also of *Larus Sabini*, and other species of arctic gulls.

Dublin

Royal Society, December 15, 1884.—Section of Physical and Experimental Science.—Dr. W. Frazer in the chair.—On a photometer made of paraffin, by J. Joly, B.E. If a prism be cut from a translucent substance, such as paraffin, and so exposed to a source of light that only one of its faces is illuminated, the light diffused through the substance and reflected out through the unilluminated faces of the prism gives it an appearance as if lighted up internally. Two such prisms laid together on smooth faces and receiving light from separate sources (placed so as to be at opposite sides of the plane of division) have the appearance of two luminous bodies laid side by side. When the quantity of light received by each prism is the same, the effect is as if the whole substance was uniformly self-luminous; and if, further, the light from each source is similar in colour, it is difficult to detect the presence of a divisional plane. The prisms are so cut as to lie symmetrically about the plane of contact, and shifted between the sources of light till the trace of the plane of division vanishes. From the close juxtaposition of the surfaces under comparison, the arrangement is a sensitive one.—On artificially-produced gold crystals, by William N. Allen. A neutral solution of chloride of gold and sodium deposited in the course of a few hours lamellæ of metallic gold, which, on examination, proved to be perfectly-formed crystals similar to the native forms figured in Muspratt's chemistry. The largest observed crystal was 3/1000 inch in diameter.—Recent advances in physical science, by Prof. G. F. Fitz Gerald, F.R.S.:—(1) The transference of energy in the electro-magnetic field (Prof. Poynting); (2) The motion of an electrified sphere (J. J. Thompson).—Note on a remarkable belt seen on Saturn on December 6 and on this evening (15th), by G. Johnstone Stoney, D.Sc., F.R.S. The belt consisted of a thin dark line, almost black, above the ring.

i.e. south of it, with a broad, shaded, bright band between it and the ring, which was so shaded as to give the appearance of a swelling round the equatorial part of the planet.—On the results of analyses of milk, cream, and butter at a recent dairy show, by R. J. Moss, F.C.S. Cream obtained by the separator was found to be very much richer in "solids, not fat," than cream obtained by the ordinary process of skimming. Butter made by different dairy-maids from the same cream and under identical conditions was found to vary chiefly in casein. The minimum quantity of casein found in this butter was 0·32 per cent., the maximum 1·17 per cent. It was observed that the specimens that received the highest awards from the judges were those that contained most casein.—A new form of ammonium chloride inhaler was exhibited by A. M. Vereker.

Natural Science Section.—On *Peachia hastata* (Gosse). Part i., description and habits, by Prof. A. C. Haddon and G. Y. Dixon. A description of the form, colour, and markings, and the variations of the conchula of specimens recently found in Dublin Bay, and an account of its habits supplementing that of Gosse.—Canadian, Archean, or pre-Cambrian rocks, with a comparison with some of the Irish metamorphic rocks, by G. H. Kinahan, M.R.I.A.—Notes on apatite from Buckingham, Ottawa Co., Canada, by G. H. Kinahan, M.R.I.A.—A set of musical stones from Cumberland, now in the Science and Art Museum, were exhibited and described by B. H. Mullen. Specimens showing the mode of occurrence of *Sclerotium varium*, Berkeley, were exhibited by T. Carroll.—The communication on *Halcampa Andresii*, November 17, was by Prof. A. C. Haddon.

Sydney

Royal Society of New South Wales, December 3, 1884.—H. C. Russell, B.A., President, in the chair.—Sir George Biddell Airy, K.C.B., F.R.S., &c., and Prof. John Tyndall, D.C.L., F.R.S., &c., were elected Honorary Members; three new ordinary Members were also elected.—The Society's medal and 25*l.* were awarded to Mr. W. E. Abbott, of Wyngen, for his essay upon "Water Supply in the Interior of New South Wales." None of the papers upon "Origin and Mode of Occurrence of Gold-bearing Veins and of the associated Minerals," or "On the Infusoria peculiar to Australia," were considered of sufficient merit to be awarded the prize. No communication was received upon "Influence of the Australian Climate in producing Modifications of Diseases."—The following papers were read:—Notes on Doryanthus, by C. Moore, F.L.S., illustrated by specimens of a new species.—Notes upon a new self-registering anemometer, by H. C. Russell, B.A., F.R.A.S.—Water-supply in the interior of New South Wales, by W. E. Abbott.—Mr. C. S. Wilkinson, F.G.S., exhibited some experiments to illustrate the nature of comets and to explain the reason for the tail being usually turned from the sun.

December 17, 1884.—H. C. Russell, B.A., President, in the chair.—Mr. Caldwell exhibited specimens illustrating his researches into the embryology of the Marsupiala, Monotremata, and Ceratodus.

Paris

Academy of Sciences, January 26.—M. Bouley, President, in the chair.—On the limit of accuracy in the differential formulas employed in the reduction of meridian observations, by M. M. Lœwy.—On the chemical neutrality of the salts, and on the use of colouring substances in the quantitative analysis of the acids, by M. Berthelot. In the present paper the author proposes to generalise the results already obtained in the use of several new colouring substances endowed with special properties of late years introduced into the process of chemical analysis. He gives the thermic interpretation of the effects distinguishing these substances, which are acids and salts whose proper reactions are determined by the laws of saline statics.—Note on the pyro-electricity of the topaz, by MM. C. Friedel and J. Curie. From their experiments the authors conclude that the crystals of topaz possess not only the already determined pyro-electric vertical axis parallel to the axis of the prism, but also a horizontal axis of pyro-electricity present at least in some specimens examined by them. But, owing to the limited number of these specimens, it is impossible clearly to define the position of the horizontal axis. The intensity of the electricity developed varies with the specimens themselves, in some of which the two extremities of the axis are of like sign, which may be explained by the existence of superimposed hemitropic lamels.—Note on the modifications produced in the chemical composition of certain secretions under the influence of epidemic cholera, by M. Gabriel Pouchet.—On the development of the egg of *Phylloxera punctata*, which infests the *Quercus sessiflora*, by M. V. Lemoine.—Chief results of the examination made at Toulouse during the years 1876-1883 of the observations of Saturn's satellites, by M. B. Baillaud.—Discussion of the results obtained with the Daguerrotype pictures of the French Commission appointed to observe the Passage of Venus in 1874, by M. Obrecht. The author concludes that the parallax of the sun, as deduced from the observations made by MM. Baille and Gariel, is found to vary between 8″·77 and 8″·33. This coincides with the 8″·66 with a probable error of 0″·06 already obtained by M. Bouquet de la Goye from the same data.—Results of the observations of the solar spots and faculæ made during the last quarter of the year 1884, by M. Tacchini. The results for the whole year, as compared with 1883, show that the period of greatest solar activity comprised the eight months from October, 1883, to May, 1884.—On a class of partially derived equations of the first order, by M. E. Picard.—On a special case of reduction in linear equations of the fourth order, by M. E. Goursat.—On the forms capable of integration in linear equations of the second order, by M. R. Liouville.—On the phenomena of condensation which take place in steam-engines during the period of admission, by M. F. Delafond.—Remarks on the dangers incidental to mechanical generators of electricity, and on the best means of avoiding them, by M. A. d'Arsonval.—On the ammoniacal sulphates of zinc, and on a means of separating a purely aqueous solution into two distinct layers, by M. G. André.—On the heat of formation of the sulphite and bisulphite of ammoniac, by M. de Forcrand.—Remarks on the cardiac hypertrophy occurring during the period of growth, usually between the years eight and twenty-one, by M. Germain Sée.—On the differential morphological characters of the young colonies of comma-bacillus cultivated in gelatine, by MM. Nicati and Rietsch.—Analysis of a chrysotile (a fibrous serpentine presenting the appearance of asbestos); a silica resulting from the action of acids on serpentine rocks, by M. A. Terriel.—Note on the geological phenomena produced by the earthquakes that took place in Andalusia from December 25, 1884, to January 16, 1885, by M. A. F. Noguès. A description is given of the crevasses, landslips, upheavals, subsidences, and other remarkable phenomena accompanying these disturbances.—M. Prestwich was elected a member for the Section of Mineralogy in the place of the late Signor Sella.

Berlin

Meteorological Society, January 6.—Prof. Muttrich gave a short historical review of the arrangements in connection with forest meteorological stations in Prussia, seventeen of which were in operation. They were established on as uniform a system as possible over regions of very wide varieties of climate: on plains and at different levels above the sea, in districts having a more continental, and in districts having a more oceanic, climate, and in leaf and pine forests. In all these places, moreover, observations were made according to precisely the same regulations. Each station was twofold, having one equipment in the wood, another in the open field; both, as a rule, at a distance of 200 metres from the edge of the wood. The observations comprised the atmospheric pressure, the temperature of the air and of the ground, the wind, moisture, cloudiness, atmospheric precipitation, and the evaporation of an open mass of water. These observations were made twice a day—at 8 a.m. and 2 p.m. The observations thus obtained were collected at the station of Eberswalde, and published regularly in monthly and yearly reports. From the body of observations made at thirteen stations in operation since 1873, Prof. Müttrich had now made a more special investigation into the influence of the forest on temperature. In order to obtain data to serve as a basis for determining the influence exercised by the forests on the daily march of the temperature, he had caused observations to be instituted in Eberswalde every two hours throughout a period of fourteen days from June 15 to 30. The graphical representation of these observations showed that the curve of temperature for the field station, starting from the point reached at midnight, sank a little at first, then rose at a quick, but later on at a somewhat abated, rate to its maximum at about two o'clock, whence it sank again, rapidly at first, then more slowly, to its midnight level. The curve of temperature for the forest station had, generally speaking, an analogous course. At midnight, however, its curve started at a higher point than that of the field station, crossed the latter at 5 a.m., and afterwards continued to be lower than the field curve, till at 8 p.m. it

intersected the field curve for the second time, and thence continued above it till midnight. The difference in the maxima of the two curves was considerably greater than the difference in their minima, that is to say, the wood exercised during the day a more powerful cooling influence than it exerted a warming influence during the night. The maximum of the forest curve, besides, occurred from half an hour to an hour later than that of the field curve. For the further study of the influence of forests on temperature, the data of the maximum and minimum thermometers were utilised. From these were calculated the daily variations of temperature for the different months at the different stations, and the yearly course of these variations for each particular field and forest station was exhibited by a curve, the abscissæ of which were the months and their ordinates the mean daily oscillations of temperature. From the curves of the various stations, special curves for the open field, the fir, pine, and beech forests were next deduced. The curve for the field station showed that the daily variations in January and February were within narrow limits and pretty similar, that in March the curve rose, then mounted very rapidly in spring and up to its summer maximum, whence in September it dropped very rapidly, abating, however, its rate of fall in October, and then creeping down very slowly through November and December. The curve for the fir forest was, in January and February, not much different from the foregoing in the same months, but the variations were smaller than in the case of the field station. The curve next rose rather more steeply on to the month of May, and after that proceeded more slowly towards its summer maximum, from which it fell, at first quickly and then slowly. All along, however, it kept inferior to the curve of the field station, the interval between the two being much greater in summer than in winter. In the pine forest the curve marking the variations of temperature showed a similar course, except that from January to April it approached much nearer the curve of the field station than did the curve of the fir forest, while in summer, on the other hand, it kept at a greater distance from that of the field station, but joined the fir-forest curve in autumn. Thus the curve of the pine forest likewise all along kept below that of the field station. The difference between them was less in winter, and in summer it was almost just as great as the difference between the field curve and the fir-forest curve. Altogether different, however, was the curve of temperature and its variations in the beech forest. In January and February it lay at but a very little interval below that of the field station, came up almost quite level with it in spring, or even shot just a very little beyond it, attained its maximum for the year in May, whence it at first rather slowly, but afterwards very rapidly, declined. In the beech forest, therefore, after it put on its full foliage in May, the variations of temperature lowered considerably, showing a very wide difference throughout the months of July and August from the variations of temperature obtained for the same period in the open field. The disfoliaged forest, on the other hand, showed hardly any sign of having affected the variations of temperature. The maxima, as also the minima, of temperatures were likewise calculated by the month for the different stations, and from the data thus obtained the annual curve was drawn. For the open field the curves of the maximum and of the minimum temperatures showed a pretty similar course, the maximum of both occurring in summer, and the rise and fall of the curves being likewise tolerably uniform. For the forest station the curves of the maximum and of the minimum temperatures were different. The maximum curve lay, on the whole, lower than the corresponding curve of the open field. It moreover attained its utmost height in May, resting there, with but slight changes, throughout the summer. In autumn the curve sank, reaching, in winter, quantities not essentially different from those of the field curve. The curve of minimum temperatures, on the other hand, in the case of the forest station, showed higher values than obtained in the case of the free station. In the pine forest the course of the minimum curve came nearer to that of the field curve, and there, too, a maximum was found in summer. In the beech forest, however, the curve attained its maximum as early as May, keeping that level pretty nearly all through the summer, but sinking more rapidly in autumn, and descending lower than did the curve of the pine-forest station. As a result of his investigation, Prof. Müttrich had arrived at certain definite conclusions respecting the influence of the forest on temperature, which may be stated as follow:—(1) The forest exercised a positive influence on the temperature of the air; (2) the daily variations of temperature were lessened by the forest, and in summer more than in winter; (3) the influence of the leafy forest was in summer greater than that of the pine forest, while in winter the tempering influence of the pine forest preponderated over that of the disfoliaged forest. An attempt to determining the influence of the forest on the mean annual temperature led to no sure results.

STOCKHOLM

Royal Academy of Sciences, January 14.—Prof. Sven Lovén gave an account of the work done last summer at the zoological station of the Academy, and of the special reports thereon by Dr. Carl Aurivillius on Ostracoda, M. Wirén on Annelida, and M. Fristedt on sponges.—Prof. Lovén also gave the results of his studies on the species of echinoids described by Linnæus, the fundamental specimens of which, formerly in the cabinet of Queen Lovisa Ulrica, exist still in part in the Museum of the Upsala University.—Prof. Nordenskjöld spoke on the inland ice of Greenland, and on the mineral dust found on the same.—Prof. Torell exhibited a geological map of the southern part of Sweden, published by the Geological Survey of Sweden, and also a map of the northern part, delineated at the same institution. He also described other geological maps of Sweden.—Prof. Smitt reviewed the travels of Dr. Emil Riebeck in Asia and Africa, and communicated a paper by the Rev. F. Hammargren on the bleating-like sound of the common snipe.—Prof. Wittrock communicated papers (1) by M. Henning, on his travels in Herjeådalen with regard to its mycology; (2) by M. G. Lagerheim, on his algological researches in the province of Bohus; and (3) by M. C. J. Johansson, on Taphrina, Fr., and the Swedish species of that genus.—The Secretary, Prof. Lindhagen, presented the following papers, viz.:—New or imperfectly known Isopoda described by Dr. C. Borvallius; on the action of the dioxide of hydrogen on earths; on the combinations of samarium; and new researches on the combinations of didymium, all by Prof. P. T. Cleve of Upsala.

CONTENTS

THURSDAY, FEBRUARY 12, 1885

IRON AND STEEL

Principles of the Manufacture of Iron and Steel. By Lowthian Bell, F.R.S.

THE work before us, as its title indicates, does not attempt to describe the plant or the manipulation involved in the successful conduct of the several processes pursued in the manufacture of iron, but is confined to a scientific discourse upon the reactions and economics of the production of iron, and more especially upon the question of the economical consumption of fuel in the blast furnace, as based upon the author's long practical experience as a Cleveland ironmaster, fortified by the results of, and deductions drawn from, the numerous and carefully-conducted experiments which he has made upon the chemistry and physics of iron-making. These results have been previously largely published at different periods in the *Transactions* of the Iron and Steel Institute; but, as the author says in his introductory chapter, they "were described in the language of the laboratory," and it is his desire in the present volume to present the general results at which he had "arrived in a more consecutive and less attractive form than that necessarily adopted under such circumstances, and to correct any opinion therein stated which further observation had shown to require modification." The book also contains some valuable considerations of a more commercial character than those usually found in scientific or technical works.

After an introductory chapter, Mr. Bell devotes a section to an interesting historical sketch, arranged in chronological order, of the progress and improvements effected in the iron manufacture, commencing with the primitive forge found in the interior of Africa and closing with the introduction of the basic process for the manufacture of steel. Then follows a chapter upon the direct processes for making malleable iron, in which the economic results of these processes, as against the indirect methods (where the blast and puddling furnaces are conjointly employed), are discussed adversely to the direct processes. Mr. Bell considers that, owing to their simplicity and the partially oxidising tendency of the operations of direct smelting, whereby the phosphorus in the ores is largely left in the slags, these processes have received during the past thirty years more attention than they merit. The author's ideal is a well-appointed blast furnace which expels oxygen from the ore, intercepts the escaping heat, and raises the product to the desired temperature in one apparatus. Owing to an erroneous assumption, viz. that the cost for melting steel [in] the open hearth furnace is the same whether pig iron and iron ore, or pig iron and scrap, are the materials employed, the author is led to compare somewhat unfairly, on p. 39, the cost for fuel and labour of the product of the Siemens rotary furnace with pig iron produced in the blast furnace. The comparison is made as though the two products were the same, whereas the rotator-blooms are used in the open-hearth steel process in lieu of malleable iron, and not as a substitute for "iron in the form of pig," and hence the comparison should fairly be made as between rotator-balls or blooms and balls or blooms of suitable quality as made by the indirect process of puddling the product of the blast furnace.

Section IV. is devoted to a brief consideration of the preliminary treatment of materials for the blast furnace, such as coking, charcoal-burning, and the calcination of ores; and with Section V., at page 61, the author commences his discussion of blast furnace phenomena, which he continues through Sections VI., VII., VIII., IX., X., and XI., devoting altogether a space of 282 pages to this division of the subject; whilst Chapters XII. and XIII., occupying only forty-eight pages, suffice for the discussion of the phenomena and economic results attending the production of malleable iron from pig iron in low hearths, together with considerations upon the action of the refinery, and of the various forms of puddling furnace, from that of Cort to the Danks, and other mechanical puddling appliances.

Section IX. gives much information of a speculative character, bearing upon the causes of the observed alterations in the relative proportion of carbon, oxygen, and nitrogen to each other in the gases withdrawn at different levels below the furnace throat. A like remark applies to the theories propounded to account for the origin and behaviour of cyanogen compounds in the blast furnace, and likewise to the explanations offered for the appearance of bodies, such as silica, lime, alumina, magnesia, oxide of zinc, and oxide of lead in varying relative proportions in the fume withdrawn with the gases taken at different depths in the furnace.

In Section X. the author maintains the conclusions previously arrived at in his "Chemical Phenomena of the Blast Furnace," viz. that in practice, when smelting Cleveland stone in well-appointed and well-managed blast furnaces of 80 feet in height and from 11,000 to 25,000 cubic feet capacity, driven by a blast heated in pipe-stoves to a temperature of from 500° C. to 600° C., that a ton of pig iron can be produced with the consumption of 20·4 cwt. of coke, which the author calculates is within 1·26 cwt. of the minimum consumption of coke required by theory to smelt a ton of pig iron from the ore in question. He maintains that such furnaces are, and must be as economical in fuel as larger furnaces driven by blast heated in brick stoves to a temperature of 800° C.; but he does not directly venture to dispute the advantage of an increased make per 1000 cubic feet of capacity effected by the larger furnaces and the higher temperatures of blast employed in them.

Mr. Bell dismisses, in the sixty pages of Chapter XIV., the consideration of the manufacture of steel by the Bessemer, the dephosphorisation or basic process, the open-hearth processes, known as the Siemens-Martin, and the ore process. The manufacture of steel in the Pernot furnace, by the cementation and the puddling process, are here also discussed, and in the same chapter are also described the reactions and investigations which resulted in the author's purifying or pig-washing process for the dephosphorisation of pig iron by means of molten oxide of iron added to the charge of phosphoric pig iron contained in a rotating furnace. Further, there is in Chapter XIV. an important sheet of six diagrams, graphically

representing respectively the order and rate of removal of silicon, phosphorus, and carbon from pig iron in the author's purifying process, in the Bessemer converter, with both acid and basic linings, during the process of mechanical puddling, in the refinery, and during the process of puddling by hand labour.

The thirty-four pages of Section XV. of the volume are devoted to the consideration of facts and figures better calculated to interest the trader and economist, than the manufacturer or scientist; it contains extracts from the statistical returns of the condition of the trade, and make of iron in Great Britain, Germany, France, Belgium, and the United States. Then there follow two sections full of interesting and valuable information upon the labour question, and the effects of free trade principles upon the iron industries. In these sections comparisons are made of the relative cost and efficiency of the British workman as compared with his continental competitor and his American cousin. Commencing with the agricultural labourer, the coal and ironstone miner, the labour employed at the blast furnace, the puddling furnace, in the Bessemer and other methods of steel production, and finally in the engineering and shipbuilding industries, the author shows that throughout, although wages are considerably higher in Great Britain than in any Continental iron-producing district, yet that the English workman, being better fed, does more work per day than his competitor; or, in other words, fewer hands are required in Great Britain than are necessary for the performance of the same work where foreigners are employed. The comparison with the labour of the United States stands, however, differently, the American workman, as a rule (not without exception), receiving a higher rate of wages than the corresponding class in England; such examples being conspicuous amongst the various classes of mechanics, while the individual labourer at the blast furnace is paid at about the same rate in the two countries; but from various causes Mr. Bell states that "the labour on a ton of metal in America amounts to nearly double, and often more than double, its cost in England," and similar results apply to the production of malleable iron by hand-puddling, or to steel ingots from the Bessemer converter.

The last chapter of the volume compares with one another the chief iron-producing countries of the world, their national resources, their competition with Great Britain in English and foreign markets, and the effects of improvements, more especially of the basic process, upon the German steel industries. Mr. Bell concludes the volume with a brief discourse upon the present prospects of the iron trade of the world, and draws the conclusion that the cost of production of pig iron and of steel cannot be materially reduced, except by the reduction of royalties, railway charges, and wages; whilst the puddling furnace is doomed to extinction by its more powerful rivals the Bessemer converter and the open-hearth steel-melting furnace; so that there is little inducement for ironmasters to incur any expense in experiments aiming at the improvement of mechanical puddling appliances. The last-mentioned conclusion is pretty generally accepted, but that the cost of producing pig iron and steel cannot be materially reduced may well be questioned when the immense developments of the last twenty years are considered; and there are many who still hope to see some continuance of this progress, possibly in the direction of a still more economical production of steel from phosphoric and other inferior ores, either by direct processes or by improvements in the existing types of procedure.

The statistical portion of the work is often very indefinite as to the date to which the figures apply to different localities, and the six sections comprised between pp. 61 and 342, treating as they do of the reactions in the blast furnace, the use and theory of the hot-blast, the quantity and quality of fuel required in the blast furnace using air at different temperatures, of the solid products and of the chemical changes as they take place in the blast furnace, on the equivalents of heat evolved by the fuel in the blast furnace, on hydrogen and certain hydrogen compounds in the blast furnace. Each of these sections contains, as might be expected, much valuable information upon the theoretical considerations affecting the combustion of fuel, the effects of increasing the height and capacity of the furnace, and the limits to which the temperature of the blast may be raised with economical results; but the sections might be advantageously condensed, and much repetition avoided, by a more systematic arrangement of the facts and data.

The chemical analyses, results of experiments, the various facts and data, statistical and otherwise, with the discussions thereon as contained in Mr. Bell's volume, make it a most important and invaluable contribution to the literature bearing upon the scientific and economic considerations of our great iron industry, and this notwithstanding that the theoretical deductions which the author propounds may fail to secure universal acceptation.

W. H. G.

PHILLIPS'S "MANUAL OF GEOLOGY"

Manual of Geology, Theoretical and Practical. By John Phillips, LL.D., F.R.S. Edited by R. Etheridge, F.R.S., and H. G. Seeley, F.R.S. Pp. 546. (London: Chas. Griffin and Co., 1885.)

THERE are two ends which a Manual of Geology, or for the matter of that of any science, may be intended to compass. It may be meant for beginners, or it may be designed for the use of advanced students. And the ways in which the subject must be handled in order to meet the needs of the two classes are essentially distinct; for it is no less true in intellectual than in physical development that the infant and the adult require different modes of treatment and different kinds of nourishment.

At the very opening of the work before us we find, on a fly-leaf by itself, evidently placed in a conspicuous position for the purpose of calling special attention to it, the aphorism, "Knowledge should be practical from the first," and directions follow as to the way in which the reader can best obtain the specimens by the aid of which alone his knowledge can be rendered practical. Such instructions would be superfluous in the case of advanced students, and we must conclude that the book is intended for beginners. We are warned in the preface that "of things good and beautiful the gods give nothing to men without great toil"; this is a truth which the real teacher never fails to impress on those whom he aspires to guide along the rugged roads that lead to the heights of learning, but at the same time he finds his first and best joy

in rolling aside as far as he can the obstacles that lie so thick on the path, and, when he cannot clear them away, in helping the novice with tender, loving hand to surmount them, and the wish that lies nearest to his heart is to make the journey as smooth and easy as is compatible with thoroughness. It can scarcely admit of a doubt that the way to do this is to begin with the simple, the known, and the certain, and gradually lead on to the complicated, the doubtful, and the hypothetical. And it is not only because it smooths the beginner's path that this is the more excellent way, it is even more than that, because it engenders from the outset a habit of clearly distinguishing between what we may fairly look upon as established truths and the things which are still matter of speculation. If hypotheses are forced on the student's attention in the early part of his career, and still more if these hypotheses are spoken of as if they were universally-accepted doctrines, the learner soon ceases to distinguish between fact and theory, and his scientific studies lead only to confusion of thought and a habit of jumping to conclusions from imperfect data.

It is for these reasons that I cannot help doubting the wisdom of introducing so early as the second chapter questions about which so very little is known for certain as the composition and condition of the earth's interior, the origin of the earth's figure, and the nebular or meteoric origin of the earth itself. The author is, however, countenanced in this by the practice of many eminent geologists, and I will not therefore press the objection; but I feel little doubt that he has not acted in the best way for the interests of those for whom he seems to have written when, only two chapters further on, he plunges into the vexed question of the origin of the crystalline schists. Chapter IV., which deals with this matter, begins, "The newest water-formed rocks are similar in appearance to deposits which are now being deposited." Not a word has yet been said about the class of rocks described as water-formed, nor any reason given why they are believed to have been formed in water. Why should this be taken for granted when it is a matter so easy to understand and about which there is so little difference of opinion? Surely it would have been safer for a beginner to make the demonstration of a proposition so simple as this his introduction to the study of geology, than to launch him at the outset on a sea of speculation when he is tossed to and fro by conflicting theories and bewildered by the opposite opinions which different authorities hold. Our author, it is true, evades this danger, but he does it in a way that is distinctly unfair to his readers. He shows that it is not impossible that crystalline schists may be produced by the metamorphism of sedimentary deposits, and then lays it down, without any further reason, that *all* rocks of this class have been produced in this way, but he says nothing to lead us to suspect that this is at best an hypothesis, still less that it is an hypothesis which many geologists decline to accept. This looks very much like one of those sweet and easy ways which are so severely denounced in the preface. Nor is his further development of the subject any less unsatisfactory. He gives one of the many reasons that have been alleged in favour of the view that granite is also a product of metamorphism; goes on to the further step that granitic rocks are the deep-seated forms of lavas, and so leads up to the conclusion that all crystalline rocks are metamorphic products. There are many geologists, myself for one, who look favourably on this speculation, who are even sanguine enough to believe that the day will come when it will be placed among established facts, but I could hardly have thought it possible that any scientific writer could have stated it in the present day as a thing about which there was no question; and it scarcely seems prudent, when geology offers us so much that is sure and certain on which to base our teaching, to choose one of the most speculative of its tenets as the foundation for a scheme of instruction.

A chapter follows on the "Nature, Composition, and Origin of the Water-formed Rocks," which illustrates under a typical form the defects and excellences of the greater part of the book. There is much admirable matter and the illustrations are well chosen, but it would be very hard to teach from this chapter. The facts are all strung together in a continuous narrative, somewhat scattered, too, so that if we wished to make out all the steps in the formation of a certain rock, say an organic limestone, we should have to pick out a clause here and a sentence there and piece these fragments together. In fact, this and many other parts of the book remind us of a formation rich in organic remains, but requiring much labour to unravel because the fossils are embedded in rock, are mixed confusedly together, and are, many of them, fragmentary. We do not put a beginner in palæontology to work on such a deposit, but let him first get systematic knowledge in a museum where the fossils have been extracted and set up in order. And it is just such orderly arrangement of the facts and the deductions that follow from them which is wanted in a scientific manual intended for a beginner; they ought not to be embedded in the text, where they have to be hunted for, but they want picking out and placing each by itself in a strong light so that they may catch the eye of the student. Again, if we remember that the materials out of which the water-formed rocks are built up were furnished by denudation, it would seem that an account of the origin of these rocks must necessarily begin with a description of the mode of action and products of denuding agents, but for this we have to wait till we reach Chapter XI. That chapter and Chapter X. furnish one of the most perfect instances of the "cart before the horse" to be met with anywhere. Chapter X. is headed "The General Features of the Scenery in their Relation to Geological Phenomena"; in it, while due weight is given to the influence of upheaval in determining the shape of surface, the large share which denudation has played in forming hill and valley is fully recognised; but it is not till we come to the following chapter that we are told what denudation is and how it works.

The author may say, however, that all this is very much matter of opinion, that I have my notions as to the way in which geology is to be taught and the order in which its subject-matter is to be presented, and that he has his. It may be so, but there are in the book slips and errors about which there can be no difference of opinion, and to which I feel sure the author himself will be glad to have his attention called. We do not generally describe charcoal as uncrystallised diamond, but this would be nearly as bad as "calcite in an uncrystallised condition" (p. 47);

we can hardly agree with the statement that "clay is identical in composition with felspar" (p. 46), when we remember that the one contains about 47 and the other about 65 per cent. of silica; it is somewhat a surprise to find the old time-honoured section of a mountain chain, given in Fig. 34, p. 80, still surviving; if one wished to select a section of what a mountain-chain is not like, here we have it. What would Mr. Huggins say to the statement on p. 17, that "the nebulæ are now known to be in no respect nebulous"? On p. 22 we are told that, "when a typical felspar contains potash, it is recognised by fracturing at right angles to the side (*sic*) of the prism." This is hardly calculated to convey a notion that potash felspar has two cleavages, and certainly gives no definite idea of the direction of either.

The treatment of the subject of joints is bewildering; it reminds me of the advice given to a youthful and diffident teacher, "If you are asked to explain any thing you don't understand, look solemn and talk of polar forces." We have vague hints that the crystallisation of monoclinic augite and triclinic plagioclase may in some mysterious and unexplained way have determined the direction of the cracks on the hexagonal jointing of basalt, and that the structure is essentially crystalline (p. 43); then, on p. 82, our mind is unsettled by the statement that tension in successively different directions is more probably the true cause of the phenomena of jointing in slaty rocks; then heat and electricity, it is surmised, may have had something to do with it. Surely in the place of these guesses, or at least in addition to them, it would have been well to mention some of the facts that throw light on the solution of the problem; that the columnar structure of basalt is closely mimicked by the hexagonal columns of starch and dried clay in the formation of which crystallisation took no share; and that Daubrée has produced, by torsional strain, cracks, the directions of which follow the same law as governs the trend of master-joints in rocks. It is this preference of shadowy surmise to solid substantial fact which constitutes one main fault of the book. The notice of "reversed faults" on p. 77 is incomplete; Rogers and Heim have taught us that these are the rule in violently contorted districts, and the latter has given a beautiful explanation of how they have been produced. The formation of coal is dismissed in ten lines, at least this is the only reference to coal given in the index, and I have not found anything on the subject elsewhere in the book. When I think what an admirable instance of inductive reasoning the discovery of the terrestrial origin of coal supplies, and how the study of sound inferences like this is one of the best ways of developing the logical faculty in the student, I cannot help regretting that some of the questionable speculations with which the book abounds have not been left out to make room for an account of the way in which this truth was arrived at. I fear very much that the directions given on p. 253 will not help the student much to identify minerals under the microscope. One would gather from them that colour was the one important point to attend to, for this is almost the only thing noticed; and it is strange that in the case of olivine, where the extreme vividness of the colours is of some little use as a distinctive test, no notice is taken of the fact. Amphibole, it would seem, is to be distinguished from pyroxene by giving brighter colours, but the widely different cleavages of the two minerals, and the dichroism of the one and its absence in the other are passed over. Nor is a word said about the dichroism of tourmaline and magnesian mica. Of the many points to be attended to only one is mentioned, and the most important facts under that head are omitted.

For such reasons as I have given I cannot help feeling that this work is unsuited for teaching purposes; indeed, on account of the way in which it mixes up theory and fact, I should say it would be positively dangerous to put it into the hands of a beginner.

But it will be by no means without its use to those who have made some progress in the study of geology. It is an admirable geological gazetteer. The long lists of localities where typical examples of the various classes of rocks may be studied and the condensed descriptions of the geological structure and history of the various districts cited, will be of great value. References to original memoirs are frequently given, but they might be largely increased with great advantage; it would be scarcely possible to make them too numerous. There is much, too, in the speculative portion of the book, which, even if it be in places hazy and but slightly supported either by observation or experiment, is still very acceptable. Even the guesses of an acute and original thinker are welcome.

In the section devoted to palæontology the puzzles and uncertainties of that branch of geology are stated without reserve, and the lines on which the palæontologist must work are clearly marked out. The chapter on the "Succession of Life in Classes and Orders of Animals" is too crowded with detail for beginners, but I fancy that the advanced student will often turn to it for reference and thank the author for having furnished him with such a concise index to the subject. The brief indications given under each head will serve as starting points, and as he develops and expands his knowledge by the aid of special treatises and original memoirs, the student will find out for himself where the author is propounding his own peculiar views, and where he is in accord with his fellow-palæontologists.

A. H. GREEN

OUR BOOK SHELF

Transit Tables for 1885. By Latimer Clark, M.I.C.E., &c. (London: E. and F. N. Spon, 1885.)

AT a period when the question of universal time is in every one's thoughts, more or less, these tables should possess more than ordinary interest. By the production of a simple, efficient, and inexpensive transit instrument Mr. Clark first demonstrated that transit observations were within the power of others than the professional astronomer or the wealthy amateur, and that by these observations timekeepers could be regulated to the fraction of a second. The next step was to simplify the calculations involved in the reduction of these observations, by the yearly publication of tables giving in Greenwich mean time, instead of sidereal time, the transits of the sun and a few of the principal stars conveniently situated for observations for every day in the year. This is chiefly what is accomplished in these tables, now in their fourth year of publication. In addition to the fundamental stars, the transits of five of which are given for every

day in the year, there are tables by which the transits of about twenty others can be computed by the simple addition of their R.A. converted into mean time from that of one of the fundamental stars. The transits of the major planets and of certain bright stars suitable for daylight observations are also given, and the tables show the declination and meridian altitude of sun, stars, and planets. There is a monthly ephemeris, and in additional tables will be found the time of sunrise and sunset, daybreak and nightfall, the sidereal time at a certain epoch of mean time (9 p.m.), and the sun's semi-diameter for every alternate day. In the preface are clearly-written instructions for fixing and adjusting the instrument, and for obtaining local or Greenwich time at any place in England or abroad. The times are given to the nearest tenth of a second, and the tables are clearly printed in bold type.

Reise nach der Insel Sachalin in den Jahren 1881-1882. Von J. S. Poljakow. Aus dem Russischen übersetzt von Dr. A. Arzruni. (Berlin: Asher and Co. 1884.)

THE author of this volume is a zoologist who filled for a considerable period the office of Conservator of the Zoological Museum of the Russian Academy of Sciences. He has also travelled widely on scientific missions in outlying parts of the Russian empire, and has already studied a portion of the zoological collections sent home by Col. Prejevalski from his Central Asian journeys. The importance which the large island of Saghalin, off the mouth of the Amour, is believed to possess for Russia, led the Geographical Society of St. Petersburg to despatch Mr. Poljakow to study the island and to report upon it from a scientific and economic point of view. He took passage from Odessa accordingly, in a ship conveying convicts, and arrived at the mouth of the Djuka, in Saghalin, in June, 1881. During the succeeding fourteen months he travelled all over the island, along the water-ways—which are the only ways there—when travelling was possible, and arranged his collections when the weather and the season rendered advance impossible. This volume is composed of the letters addressed to the secretary of the Geographical Society, detailing his movements when travelling. For the most part they are such as the most unscientific traveller might address to a friend: they describe the incidents of his various journeys, the superficial customs of the natives he met, the difficulties of travel, his views of the island as a penal colony, its agricultural and mining prospects, and much else of a general and chatty kind. Here and there in the course of the narrative it is apparent that behind these ordinary incidents of travel there is a scientific purpose, which only comes out casually and by chance. Not that there is any concealment about the work; but the real results of the exploration will probably need more examination and arrangement than he has yet been able to give to them. Towards the end he summarises his work in the island, and the summary is worth giving, as showing us what we may expect from him now that he has time for study and arrangement. His collections on leaving the island were, he tells us, enormous. He possessed all the most important representatives of the mammals, birds, fishes, and amphibia, as well as numerous examples of the lower animal world—insects, crustacea, mollusks, &c. One of the most important places in his collection is occupied by ethnographical and anthropological objects. He has ample material to investigate and characterise the original population of the island, which has now disappeared, viz. that of the Stone Age, as well as the race which dwelt around Patience Bay, and which knew the use of metals. It is highly probable, he thinks, that aborigines who belonged to the Aino stem were so numerous a century and a half or two centuries ago at the mouth of the Poronai River that their settlements on a limited space then contained a larger population than the whole of the island does to-day. The present inhabitants, the Gilyaks and the Orokos, have retained many of the characteristic features of the culture of their predecessors. The present inhabitants of Saghalin, like the former, concentrate all their activity in hunting and fishing, and they seek their sustenance on the land as well as in the seas and rivers. He notices that the natives, and especially those of the southern part of the island, have been largely influenced by the Japanese, who go there in the summer to catch fish, and that this influence has lasted for centuries. It is only a few years since the Russians commenced to settle Saghalin, in order to introduce European agriculture and industry. Their first task was to work the coal-measures and to develop agriculture and stock-raising. But there are great difficulties to be overcome. Coal-mining, Mr. Poljakow thinks, will be successful when the methods are completed, the prices lowered, and the delivery of the coal on board ship rendered easier. The rough and cold climate must always be an obstacle to farming; marshes cover a large part of the island, and the larger rivers are subject to frequent alteration of their beds. In fact, the climate and topography of Saghalin offer no natural advantages that would lead one to prophesy smooth things of its agricultural future. The development of the fisheries would form an undoubted source of income, as salmon and herrings are numerous and can easily find neighbouring markets. "I left the island of Saghalin," concludes Mr. Poljakow, "persuaded that it was possible—nay, advantageous—for the State to cultivate, even if forced labour has to be employed. On the other hand, it was clear to me that the results obtained so far by no means correspond with the means and efforts directed to that object." The absence of a map, however small, to accompany the book is a serious inconvenience.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Gardiner's Researches on the Continuity of Vegetable Protoplasm

DR. JULES SCHAARSCHMIDT, in a paper (NATURE, January 29, p. 290) on "Continuity between the Protoplasmic Contents of Adjacent Cells in Plants," gives what he calls "the history of this subject." But he makes no reference to the elaborate memoir by Mr. Walter Gardiner which I communicated on behalf of that gentleman to the Royal Society. This was read on April 26, 1883, and is published in the third part of the *Philosophical Transactions* for that year.

Dr. Schaarschmidt states in his communication that in 1884 he "claimed the universality of the communication (at least in tissues)." I do not myself feel that the establishment of individual claims to unoccupied territory is as important in the scientific as it appears to be in the political world. Still I think it is only due to Mr. Gardiner to quote in reference to this statement of Dr. Schaarschmidt's, the following passage (the italics are mine) from the conclusion (p. 858) of Mr. Gardiner's memoir:—

"Although I am aware of the danger of rushing to conclusions, I cannot but remark that when these results—which were foreshadowed by Sachs and Hanstein when they discovered the perforation of the sieve-plate—are taken in connection with those of Russow, it appears extremely probable that, not only in the parenchymatous cells of pulvini, in phlœm parenchyma, in endosperm cells, and in the prosenchymatous bast-fibres, is

continuity established from cell to cell, but that *the phenomenon is of much wider, if not of universal occurrence.*"

Kew, September 7 W. T. THISELTON DYER

A Plea for the Experimental Investigation of some Geological Problems

THE subject of terrestrial physics involves the study of such a large number of phenomena that it is quite comprehensible that any one investigator must devote himself to only one or two branches of it at the most. The consequence of this is that from time to time some section of this extensive field of research is for a period neglected. Such is really the present state of experimental geology, and especially that branch relating to movements of the earth's surface.

Disturbances perceptible at the terrestrial surface may be looked upon as made up of three very distinct groups: first we have actual upheaval or depression of comparatively large tracts of land. Secondly, we have true earthquakes, which probably are dependent upon a variety of circumstances, as, for instance, the snapping of a rock stratum brought to the limit of its flexibility in consequence of the first group of movements; or the formation and injection of fissures by igneous matter. Lastly, there exists a series of small disturbances imperceptible to our senses and even to ordinary instruments of earthquake measurement, and only di coverable by special delicately constructed apparatus. They seem to be dependent upon a variety of causes, amongst which are those of the two former groups, together with changes dependent upon or in relation with barometric pressure, tidal action, temperature of the air, rainfall, &c.

The upheaval or depression of our earth's surface is the very basis of geological science, for it is in consequence of this that rocks have been brought within the reach of investigation, and that our globe has some dry ground upon which we can live, instead of one continuous expanse of ocean. The changes of level were suppo ed by the cataclysmic school of geologists to occur suddenly, bringing about entirely new distributions of land and water in a short period of time. Lyell, as the leader of the uniformists, laboured all his life to prove that these upheavals were in the main a slow and gradual process, extending over long periods of time. One of this author's examples which he brought forward in the argument with as much skill and force as an accomplished counsel would have done in pleading a cause, was the renowned (so-called) temple of Serapis at Pozzuoli. This building was for half a century the subject of almost innumerable books and pamphlets, some of which show a vast amount of ingenuity. None perhaps were more elaborately worked out than the volume of researches on the phenomena of this building and the neighbouring coast from Gaeta, around the whole gulf of that name, together with the Gulf of Naples, to the Punta Campanella. The author there brings forward a large amount of genuine evidence to show that during the last 2000 years the whole coast has been in a state of oscillation, so that the relative change of level of the land and sea has been as much as 12 m. So far as Niccolini's investigations were capable of being carried out, abundant evidence showed that about the second or third century B.C. the coast line commenced to descend, and continued to do so gradually until the 10th or 11th centuries, when elevation took place for nearly 6 m., till in the sixteenth century, when depression again set in. This depression is now going on in a remarkably rapid manner. I have in my possession an engraving of the temple of Serapis, in which the base of the three columns stands on the upper antique pavement of the building, which is perfectly dry. This is dated 1810. In Niccolini's work is another drawing, made in 1845, in which water had commenced to collect, so that it was necessary to wade about. In 1879 a layer of earth of over a metre had been spread over the floor to make access convenient, the standing column being surrounded by brickwork cylinders, and standing in water of over a metre in depth. The ground was then dry, but from time to time when I visited the building I found puddles commenced to collect, which at last grew so large and deep that lately an additional layer of sea-sand has been added to further raise the level. Similar variations have been observed in other parts of both of the Mediterranean and Adriatic coasts of Italy, which all seem to indicate that this geologically speaking young peninsula has not yet stopped growing.

But if the coast-lines are altering, are we not justified in supposing that the axial ridges of the Apennines are not doing so also, even in all probability to a far greater extent, though from the want of a fixed datum-line, such a the sea may afford, we are unable to appreciate the amount of disturbance? It is not likely that this change of levels exceeds 50 m. in historic times in Italy.

If we even accept the recent reports from Spain as gross exaggerations, we cannot well believe them to be pure inventions when changes of 400 m. are spoken of, which could hardly be asserted without some foundation of truth.

Now, are we not bound in some way to investigate these phenomena, which involve the very principles of geological science? It is strange, but true, that around the Gulfs of Naples and Gaeta no instrument exists for registering the relative level of the sea, nor do there exist any marks on rocks that are officially looked after. During the earthquake of Ischia of 1883 it is not known whether any disturbance of the sea took place, and we are perfectly ignorant of the rate and other characters in the change of the relative levels of the land and sea.

But putting aside this gradual elevation or subsidence, are we not permitting to slip by one of the mo t remarkable examples of quick elevation and depression which from the accounts that now reach us are taking place in Spain? Were the reports as to changes of three and four hundred metres true, we should be compelled, to a certain extent, to accept in part the teachings of the cataclysmists.

It seems regrettable that England, which is the mother country of geology, should allow such an opportunity as the Spanish peninsula now presents for the investigation of important terrestrial disturbances to slip by. Even if the earthquakes themselves are not studied, little expense of time or money would be necessary to chronicle at least the principal phenomena now in progress, which the Royal or some other Society might well take up. H. J. JOHNSTON-LAVIS

Iridescent Clouds

THE letters of Prof. Piazzi-Smyth and Mr. J. Edmund Clark (vol. xxxi. p. 148) on iridescent clouds, while interesting, do not, if I mistake not, record any new phenomena. The descriptions given agree very well with that of a phenomenon which I have observed here several times, and which is described in Herschel's "Meteorology," p. 225. Here the phenomenon is usually seen before the approach of the monsoon, and is looked upon as a sign of its being near at hand. Under these circumstances it can hardly be admitted that they have any connection with the cloud glows of which so much have been written, and which, as observed from the top of Dodabetta (8600 feet), are as brilliant as ever when the atmosphere is sufficiently dry.

It may perhaps still be of interest to some to know that observations made on the spectrum of the sun when seen through mists from the same hill-top, showed that the spectrum of the "green sun" can be completely reproduced by superposing the spectra of sunlight passing through a mist and through a thick layer of moist air; and it is probable that all cases in which the sun has been seen green can be thus explained. C. MICHIE SMITH

The Christian College, Madras, Janua y 1

Science Teaching in Schools

IN the discussion as to the teaching of science I have failed to find any distinct expression of an element in the subject which has for years seemed to me of the highest importance, and to which I should like with your permission to call attention. In those of our schools where science is taught it is almost always taken up late in the boy's career, often when he is passing from the lower to the upper school. This I feel sure is a mistake. Think for a moment of the process of evolution of that phenomenon—the English schoolboy. In too many cases he passes through the first, second, and third forms of a school, learning little more than the habit of diligent plodding, and developing little more than the art of storing away an unheard-of quantity of dry facts. He learns, for instance, page after page of grammar rules; he learns rules for making numerical transformations; he even learns in the same fashion answers to questions that examiners are known to set for the purpose of finding out whether the pupil has been *intelligently* taught! The habits so acquired are valuable, but they are acquired at the risk of sacrificing the boy's freshness, and with the subjugation of his habit of independent reasoning. After several years of such training the herald of science comes forward with such a

scheme as Prof. Armstrong very properly suggests. The would-be disciple of science is thunderstruck (as probably not a few teachers of science were when they first saw the scheme), but the novelty of the situation, the sight of new appliances and strange results, enable him to pull himself together, and his interest for a time keeps up. Presently he is asked to conduct for himself some simple steps of deductive reasoning; he fails, the whole business is a new world to him, and in the misery of his wishfulness to do something, he beseechingly asks for more dry facts to devour. What is the ultimate result? If science is to be taught effectually *it must begin with the earliest years of the educational career*, and there is surely no subject that lends itself more appropriately to the youthful mind. Children delight to talk of flowers, of insects, of the wonders of nature; they are ever asking suggestive questions; they are indefatigable collectors of objects of beauty; the Kindergarten system has acknowledged that the child is an orderly being delighting in symmetry and colour. Yet we increase his vocabulary by the word "star" and fail to tell him anything of the wonders of stardom. Why, our very fairy tales are based on just such fabric! To effect this early introduction of science the very best and most considerate teaching is required, as indeed it is a much more difficult task to guide the young student's thoughts than to guide the veteran student's reading. We want, further, a well thought-out progressive scheme of simple general science which shall be suggestive to the teacher of the course to be pursued. To draw up such a scheme is, I am quite aware, not a matter of moments: it would require the association of many minds and many sympathies.

Something in this direction has been done in France, and good text-books are to be found in the English science primers and in Paul Bert's Book of General Science for the Young; text-books, however, are not an immediate want—for the matter of that, the pupil may make his own—we do, however, want that which will help the conscientious teacher to see how he may make the teaching of science interesting, intelligent, and above all progressive. We cannot afford to wait for unintelligent teaching to die a natural death, remembering that there is in England no criterion that the teacher in the middle-class school can *teach*, that teaching does not pay in examinations, that the dry-bones method lends itself most readily to school discipline, and finally, that the subjects chiefly taught are of such a nature as almost to preclude any other method with the young. Under the present *régime* science is not a growth, it is a graft, and a graft, it is to be feared, of a most unfortunate nature; the sooner it develops roots of its own the better. It is, under the circumstances, no cause for wonder that the more advanced student flounders over common general principles. I have confined my remarks, for the sake of definiteness, to middle-class schools, but they are, I believe, with unessential variation, applicable to the general question of the teaching of science. G. H. BAILEY

Heidelberg, February 3

Barrenness of the Pampas

I AM anxious to add a few further remarks on this interesting subject. It was during its investigation that I was so deeply impressed with the desperate struggle for existence which characterises the bordering fertile zones. I could there watch the contest on the very battle-field itself, and for that purpose I established myself for some months in the north of Uruguay, away from all other habitation, among the wooded banks and lagunes of the River Arapey. This river, though normally a quiet stream, is subject to tropical floods, during which the water rose often thirty feet in eight hours. The "monte," or fertile wooded belt on each side, is intersected with ravines and lagunes teeming with animal and vegetable life of singular interest. The alligator, carpincho, myopotamus, nutria and other and numberless snakes thrive in the marshy swamps, while in the woods we met with the puma, the jaguar, the great lizard, the Podinama, the *Nasua socialis*, and numerous other singular animals and birds described in my little book. But it was among the flora that the principle of natural selection was most prominently displayed. In such a district, overrun with rodents and escaped cattle, subject to floods that carried away whole islands of botany, and especially to droughts that dried up the lakes, and almost the river itself, no ordinary plant could live, even on this rich and watered alluvial *débris*. The only plants that escaped the cattle were such as were either poisonous, or thorny, or resinous, or indestructibly tough. Hence we had only a great development of solanums, talas, acacias, euphorbias, and laurels. The buttercup is replaced by the little poisonous yellow oxalis with its viviparous buds, the passion-flowers, asclepiads, bignonias, convovuluses, and climbing leguminous plants escape both floods and cattle by climbing the highest trees and towering over head in floods of bloom. The ground-plants are the portulacas, turneras, and œnotheras, bitter and ephemeral on the arid rock, and almost independent of any other moisture than the heavy dews. The pontederias, alismas, and plantago, with grasses and sedges, derive protection from the deep and brilliant pools; and though at first sight the "monte" doubtless impresses the traveller as a scene of the wildest confusion and ruin, yet, on closer examination, we found it far more remarkable as a manifestation of harmony and law and a striking example of the marvellous power which plants, like animals, possess of adapting themselves to the local peculiarities of their habitat, whether in the fertile shades of the luxurious "monte" or on the arid, parched-up plains of the treeless Pampas. EDWIN CLARK

Great Marlow

Recent Earthquakes

WITH reference to the statement in NATURE, vol. xxxi. p. 262, that the earthquake of December 25, 1884, was registered by the magnetic variation instruments in London, permit me to inform you that an effect was also noticed on a curve of the magnetograph at the Imperial Marine Observatory, Wilhelmshaven. But while at London declination and bifilar were specially affected, here only the Lloyd's magnetic balance, the instrument for vertical intensity, was set in oscillation, first at 9h. 52m. p.m. local time. Full details will be published in the *Zeitschrift* of German Meteorology. Dr. M. ESCHENHAGEN

Wilhelmshaven, February 6

MR. W. A. SANFORD, in NATURE of January 29, p. 289, says on the above subject:—"It would be interesting to know whether anything of the same kind [as described in his letter] had been observed elsewhere at the same time." I have been collecting observations on this subject for a continuation of my paper on earthquakes in Devon, published in the *Transactions* of the Devonshire Association. The Vicar of Bampton has very kindly given me his experience of the earthquake, as the wave appeared to have passed very near, if not directly under, his house. Bampton is seven miles north of Tiverton, and about a mile inside the junction of the Carboniferous and the Devonian systems, situate on a rather large patch of limestone. The time the earthquake occurred there was 8.42 p.m. In the drawing-room at the vicarage it appeared as if a heavy traction-engine was passing close to the window; the window faces eastward. In the kitchen the servants were greatly alarmed by a rumbling noise and a shaking under the floor. Some of the Vicar's neighbours say they heard a report, and houses with cellars under them and higher felt the shaking more; some persons who were up stairs, thinking that it was some explosion, rushed down stairs and out of doors. The effects were also felt at Shillingford, two miles distant, and also at Combehead, one and a half mile distant. The porters at the station describe it as like a heavily-laden mineral train passing. The only damage done at Bampton was a piece of wall was thrown down. This was undoubtedly the same shock or seismic wave as mentioned by Mr. Sanford as occurring on the night of Thursday, January 22, and would appear to have travelled from east to west. EDWARD PARFITT

Devon and Exeter Institution, Exeter

Loligopsis ellipsoptera

COULD you allow me space to ask whether any of your readers can give me a clue to the present locality of the type-specimen of *Loligopsis ellipsoptera*, Adams and Reeve, obtained during the voyage of the *Samarang*; and also to state how grateful I should be to any one who can lend me specimens of that genus or of others allied to it? WM. E. HOYLE

Challenger Expedition Office, 32, Queen Street, Edinburgh, February 9

L. WRAY, JUN.—Your supposed dragon-fly belongs to the family *Ascalaphidæ*, allied to the ant-lions.

CIVILISATION AND EYESIGHT

In his interesting paper on "The Influence of Civilisation upon Eyesight," read recently before the Society of Arts, Mr. Brudenell Carter supports the commonly received view that the vision of savages is far more acute than that of civilised men. In some sense this is doubtless true; but that the eyes of savages, considered merely as optical instruments, are greatly superior to our own appears to be inconsistent with optical laws and facts long since established by the labours of Airy, Helmholtz, and other investigators. It is known to physicists that the resolving power of an optical instrument is limited by its *aperture*. With a given aperture no perfection of execution will carry the power to resolve double stars, or stripes alternately dark and bright, beyond a certain point, calculable by the laws of optics from the wave-length of light. With sufficient approximation we may say that a double star cannot be fairly resolved unless its components subtend an angle exceeding that subtended by the wave-length of light at a distance equal to the aperture If we take the aperture of the eye as 1·5th inch, and the wave-length of light as 1-40,000th inch, this angle is found to be about 2 minutes; and we are forced to the conclusion that there is no room for the eye of the savage to be much superior in resolving power to those of civilised physicists, whose powers approach at no great distance the theoretical limit as determined by the aperture.

It has always appeared to me that the superiority of the savage is a question of attention and practice in the *interpretation* of minute indications, and that it is comparable with the acuteness of the blind in drawing conclusions from slender acoustical premises. It would be an interesting subject for investigation, but I should not expect to find that when put to a direct test blind people were able to hear sounds wholly inaudible to others.

The increasing prevalence of short sight is a very important matter, worthy of all attention. There is one fact in connection with it which I avail myself of this opportunity of mentioning, in the hope of inducing scientific oculists to give it further examination. I find that, though not at all short-sighted under ordinary circumstances, I become decidedly so in a nearly dark room, seeing much better with spectacles of 36 inches negative focus. In a moderately good light I see rather better without the glasses than with them. From the few observations that I have made I have reason to believe that this peculiarity of vision is not uncommon. With the aid of a set of concave glasses it is easy to try the experiment in a room lighted with gas. The flame should be gradually turned lower and lower, so as to give full time for the pupil to dilate, and for the eye to acquire its maximum sensitiveness. In my own case the most marked indication of better definition is the augmentation of binocular relief.

RAYLEIGH

THE INTERNATIONAL INVENTIONS EXHIBITION

There seems now little reason to doubt of the success of the South Kensington Exhibition of next summer—success, that is, from an educational and scientific point of view. What its financial result may be depends upon a variety of circumstances, and perhaps, since it is very improbable that there can be any serious deficit, while, if there is a large surplus, its disposal will, as usual, form a problem difficult of solution, this part of the question does not really very much matter. That Londoners will have a pleasant outdoor lounging place, that there will be abundance of music, that the fountains will be as pretty as last year and the gardens prettier, all this may be taken for granted; but there now seems every reasonable expectation that we shall have more than this, and that the Exhibition will be what it professes to be—a complete illustration of the progress made in the application of science to industry during the past twenty years. At all events if it is not it will be the fault of the promoters, since they have had so large a range of choice that it has only been possible to find space for some third of the applicants, and an enormous number of exhibits have been rejected, not because they were unsuitable or uninteresting, but simply because, when there was not room for all, some must of necessity be excluded.

To begin with, it was thought best to exclude, not only the actual articles which were shown last year, but inventions of the same class, and consequently there will be found at South Kensington this year few, if any, exhibits relating to food, clothing, or sanitation. It appears that this rule has given rise to a certain amount of heart-burning, since reference is found to all these heads in the official classification; but it must be remembered that the announcement was duly made at the beginning that the space to be allotted to these and certain other classes would be strictly limited, and then again it was impossible to foresee how large would be the response to the invitations issued. The task of selection has been a difficult, and indeed an invidious, one; but we think it will be found, when the show is opened in May next, that this thankless task has been performed with great judgment, and with a just consideration of the claims of exhibitors on the one hand, and the interest of the public on the other.

We are glad to have heard that in none of the thirty-one groups into which the inventions' half (we are not now considering the musical part) of the Exhibition is divided, have the applications been deficient; in some they are naturally better than others, but in every one there is enough to provide a fair representation of the condition of its particular industry, and of the improvements which have been made in it during the limits of time with which the Exhibition is concerned. Even this will doubtless be a cause of complaint to those who believe that injury will be done to our manufacturers by the opportunity given to foreigners of imitating our wares and the methods by which they are produced. This is a specious but a somewhat narrow-minded notion; the early history of invention is full of stories of the efforts of inventors to keep their inventions secret, and the constant failure of such efforts may be taken as one of the principal causes which produced the modern Patent system, under which an inventor is protected, so far as law can protect him, in the enjoyment of the property he has created. There are, of course, many instances of processes worked, and successfully worked, in secret; but these are the exception, and on the whole it is found that inventors individually, and industry generally, gain far more by a system of publicity than by one of concealment. So it is with exhibitions. It may be taken as tolerably certain that manufacturers who have any special process which they desire to keep to themselves will not select that particular process for exhibition, and that on the whole manufacturers find exhibitions profitable or they would not be so anxious to engage in them. The suggestion that was made by some wiseacre that the Exhibition should be confined to untried inventions, so that manufacturers (who of course have no other means of hearing of novelties in their own trades) might have the benefit of seeing them, does not, perhaps, call for serious refutation. If the curious collection of rubbish which fills the big building at Washington, devoted to the United States Patent Office, were carted across the Atlantic, and placed in the Kensington Galleries, it is a question whether the public would be more bored, or the manufacturers less instructed.

As would naturally be expected, in an exhibition of this character, machinery will occupy a far larger proportion of the space than on previous occasions; we understand that it has therefore been necessary to make considerable additions to the motive power provided for the

use of exhibitors. Besides the engine which supplied power in the machinery gallery last year, an engine is being erected in the new gallery which is being put up along the north side of the old South Gallery, as described in the *Journal* of the Society of Arts for January 30. A third engine will also be provided, which will drive machinery in one of the Foreign Courts. It will thus be seen that those visitors who have mechanical tastes will be amply provided for.

As regards the prospects of applied chemistry, we are not able to speak so confidently. Probably the completeness of this portion of the show will almost entirely depend on the success of the efforts which are being made by the Society of Chemical Industry to secure a collective exhibit. The announcement made by the executive at the outset, that it was desired to show processes rather than products, is believed to have kept back many manufacturers from seeking to show specimens, while it is obvious that but few chemical processes could conveniently be carried on in an exhibition gallery. Possibly this rule might have been abrogated as regards the chemical section, and we believe that no attempt will be made to enforce it with reference to the collection of the Society of Chemical Industry, in which it is proposed that the information required shall be given by means of a collection of pictorial diagrams, exemplifying some of the more interesting or more important chemical operations.

As our readers are aware, a similar work is being undertaken by the Physical Society in the class devoted to "Philosophical Instruments and Apparatus," though in this case there will be less left for the society to do, since the principal makers of apparatus have come forward in sufficient numbers to ensure a good representative collection. The object, however, of the Society in exhibiting has been not so much to supply deficiencies, as to show the work which has been done by its own members. We believe that the Kew Observatory and the Meteorological Society will also be among the exhibitors, the latter in their old place in the grounds. Besides this, a very interesting exhibit is promised namely, a fully fitted observatory, which we understand one of our best known makers had offered to fit up.

In the class devoted to Photography, which comes next both in the classification and in actual position in the galleries to the philosophical instruments, the Photographic Society has undertaken to form a collection of apparatus and specimens not likely to be shown by makers. It appears that the Society intend to go a little beyond the precise limits of the Exhibition, and to show a collection of examples illustrating the entire progress of photography from the inventions of Niepce and Daguerre, and it may doubtless be assumed that in so special a case no objection will be raised, especially as but a very small space indeed, and that only on the walls, will be required for what cannot fail to prove a most instructive and interesting collection.

The progress which has been made in electric lighting has indeed been sufficiently illustrated in the exhibitions of last and of the preceding year; in fact, the Health Exhibition offered almost the only public example of any progress at all in England. Doubtless the lesson will be repeated this year, and on a more extended scale, for we learn that considerable additions are being made to the arrangements for electric lighting of the buildings, while it is intended to use the light also for the garden illuminations, an improvement due to the energy of Sir Francis Bolton. If this idea is carried out on the plan which we understand is intended, the instantaneous lighting up of the myriad incandescent lamps by which the gardens are to be illuminated will certainly be one of the most popular, and one of the most wonderful, sights in London next summer.

The above remarks refer only to the English portion of the Exhibition. How much will be contributed by foreign countries it is not yet possible to ascertain. Thanks doubtless to the efforts which were made by certain of the members of the British Association who were in the States last year, the American Court promises to be well filled, and it must be admitted that in the present Exhibition, if we get American ingenuity well represented, we shall not very greatly miss the contributions of other countries, though we hope, all the same, that these will not be lacking.

THE RETINA OF INSECTS

IT might have been thought impossible for any one who has studied the eyes of Arthropods to doubt that the so-called retinulæ are really the nerve-end cells of the eye, and correspond with the rods and cones of the vertebrate eye. The evidence in favour of this view accumulated by the researches of almost every observer, including such eminent authorities as Johannes Müller, Leydig, and Grenacher is so overwhelming that of late years no one has thought fit to dispute it.

Mr. Lowne has, however, at last attempted to overthrow this theory, and in a paper just published in the *Transactions* of the Linnean Society, vol. ii. part ii., on "The Compound Vision and the Morphology of the Eye in Insects," has brought forward certain statements to prove that all the parts of the eye in front of the basilar membrane are dioptric, whilst the true (?) retina is situated behind it.

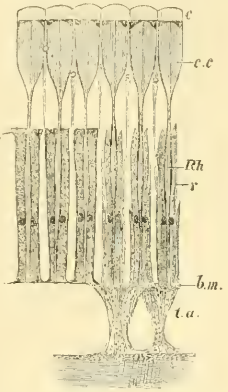


Fig 1.

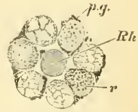


Fig 2.

FIG. 1.—Section through the eye of Squilla, showing the distribution of the ultimate nerve fibrils to the retinulæ. The Ommatidia to the left of the figure are drawn with their accompanying pigment cells (*p g*) complete; in the three to the right these are omitted in order to show more clearly the distribution of the nerve fibrils; *c*, corneal facets; *c.c*, crystalline cone: *rh*, rhabdom; *r*, retinula; *b m*, basilar membrane; *t.a*, terminal anastomosis of optic nerve fibrils supplying the retinulæ.

FIG. 2.—Transverse section through the ommatidium of Squilla, showing the seven retinula cells surrounding the central rhabdom. The retinulæ are seen to possess a considerable amount of granular pigment, which is unevenly distributed in the different cells.

To one who has been devoting considerable time and attention to the eye of Arthropoda, this proposition is particularly striking and unexpected, and many points at once occur which show that it is untenable.

In the first place it is untenable because we have ample evidence to show that the original theory is the true one. The nerve-end cells throughout the animal kingdom have certain definite characteristics. They are the cells in which the ultimate fibrils of the optic nerve terminate, and no nerve fibrils have ever been seen to leave them to supply other parts of the eye; and, in the second place,

they are always pigmented either by a diffuse fluid "retinal purple," or by pigment in granules, or both.

In both these particulars the retinulæ of Arthropoda resemble the nerve-end cells of other animals.

It is hardly necessary to point out that Leydig, Max Schultz, Grenacher, and many others, have traced the optic nerve fibrils to the retinulæ. I have in my possession several series of preparations showing this both in insects and Crustacea, and any one can readily see this for himself by making even clumsy sections through the eye of Squilla.

In Fig. 1 I have figured the nerve fibrils of the eye of Squilla perforating the basement membrane and entering the retinulæ, and in Fig. 2 a transverse section through the rhabdom and retinulæ showing their relative position and numbers.

A special feature of the retinula is that it is always pigmented. In specimens hardened in spirit a granular pigment may be seen in the retinula cells, which is usually of a light-brownish colour and very unevenly distributed (Fig. 2). But in addition to this granular pigment, the retinulæ contain a true retina purple, which fades upon exposure to the light. This was discovered in 1864 by Leydig[1] in the following genera of Insecta:—Procrustes, Scarabæus, and Pieris, and in Astacus among the Crustacea. I have also seen it in *Musca vomitoria*, and have now no doubt that it exists in the Arthropod eye generally.

So far, then, I think it must be admitted that both anatomical and physiological considerations tend to prove that the retinula is the nerve-end cell of the Arthropod eye.

When we turn to morphology, too, we have confirmatory evidence that this is the case.

In the ocellus of the water-beetle larva the retina is a simple cup of pigmented hypodermis cells, in which the optic nerve fibrils may be readily seen to terminate. These cells are most certainly homologous with the retinula cells of the so-called "compound" Arthropod eye, as has been already shown by Grenacher in his important treatise, "Untersuchungen uber das Sehorgan der Arthropoden" and elsewhere, and confirmed by the more recent researches of Lankester and Bourne upon the eyes of Limulus and the scorpions.

The researches of Claparède and Weismann on the development of the eye of Arthropods confirms the deductions of morphology, by proving that the cells which ultimately form the retinulæ are specially modified hypodermis cells, and at an early stage come into connection with optic nerve fibrils. If any further evidence were required to confirm this homology it can be readily obtained by studying the eyes of very young cockroaches, in which the retinulæ at the periphery of the eye are formed from specially modified and deeply pigmented hypodermis cells.

But it is tedious and unnecessary bringing evidence of this kind to confirm a theory which is already fully established in the minds of most naturalists. In fact we have here an instance in which morphology, physiology, comparative anatomy, and development combine to establish an homology, and consequently we must definitely assert that the retinulæ are the nerve-end cells throughout the Arthropoda. But what is the meaning of Lowne's bacillar layer behind the basilar membrane? and does it exist in all Arthropods?

It is perfectly true that behind the basilar in many Diptera, Coleoptera, Lepidoptera, and Hymenoptera there is a layer composed of a number of small cylindrical masses which has a superficial resemblance to the rods of the Vertebrate eye, but Mr. Lowne did not *discover* this layer in any sense of the word, for it was perfectly well known to Leydig, who figured it in *Formica rufa*, *Dytiscus marginalis*, and *Sphinx ligustri* (*vide* Leydig's Tafeln, viii. ix. x.). The little cylindrical masses cannot be regarded as cells, nor rods, nor bacilli, for each one of them is composed of a very fine reticulum of nerve fibrillæ which is in direct communication with the optic nerve fibrils behind, and the terminal anastomosis of the optic nerve fibres in front. In fact, these "bacilli" of Lowne are connected with nerve fibrils on both sides, and thus differ from "nerve-end cells" in one of their two fundamental characters.

Very often, too, this layer is quite devoid of any pigment (Apis, Eristalis, Bombyx, Squilla, &c.), and no one has ever yet been able to demonstrate the presence of retina purple in this region.

Another important difficulty in the way of accepting this theory, too, is the fact that this layer is not always present (Periplaneta, Nepa), and in all Crustacea and many insects it cannot be divided into separate bacilli.

I have lately paid considerable attention to this part of the optic tract, but must defer a fuller explanation of the meaning of it until I am able to publish my paper in the *Quarterly Journal of Microscopical Science*, when I shall be able to illustrate my researches by several figures. To summarise, however, the evidence against this layer being composed of nerve-end cells: We find that it is certainly not homologous with the retina of other animals; optic nerve fibrils both enter and leave it; it is devoid of retina purple or of any other form of pigment in many Arthropods, and finally it is absent as a bacillar layer in many insects and in all Crustacea. In fact we can bring as much evidence to prove that this is not the retina as we can to prove that the retinulæ are the true nerve-end cells.

At the conclusion of his paper Mr. Lowne says, in referring to a recent memoir of Justus Carrière of Strassburg, "He remains, however, a disciple of established views, and has not given the retinal layer nearly so much attention as it deserves." I have given the retinal layer as "much attention as it deserves," and must also claim to remain a "disciple of *established* views."

SYDNEY J. HICKSON

[1] Leydig, "Das Auge der Gliederthiere." Tübingen, 1864.

RORAIMA

A TELEGRAM has been received at Kew giving the welcome news that Mr. Everard F. im Thurn has at last ascended Roraima. This has been the cherished object of botanical exploration in South America for the last quarter of a century. The expenses of Mr. im Thurn's expedition have been borne in equal shares by the Government grant of the Royal Society and the Royal Geographical Society.

The latest news from Mr. im Thurn was in a letter dated December 6 from the south side of the mountain, and the following passage describes the position immediately before the final attack:—

"Before we came to Roraima itself we had four days walking through a purely savannah, but most glorious country, and over splendid mountain passes, guided by an Arecoona who said, villain that he is, that he knew the way to Roraima. But at a village marked on the map as Ipelemonta, on the Aroopa River, and with a considerable mountain pass still between us and Roraima, our villain guide at last admitted that the road for some distance had been quite new to him, and that he now knew not how to proceed further. However, at last we procured a guide, and came, in some four hours, out of our difficulties at Ipelemonta (its real name, by the way, is Toorarking), into this inconceivably magnificent valley, and are installed in a village on the actual southern slopes of Roraima itself.

Yesterday Perkins and I ascended the slope of Roraima to a height of 5600 feet to a most beautiful spot—a very garden of orchids and most beautiful and strange plants. To-morrow, after despatching the bearer of this scrawl, we

go up to the same place with a lot of Arecoonas, who are to build us a house, in which we intend to stop for a week or as much longer as we may find desirable. I may mention that we have already seen, close to where our house is to be, a place where the mountain *seems* accessible; but it looks so easy that I am convinced that it is impossible at that point."

BENJAMIN SILLIMAN

DURING the American War of Independence many men were called on to leave peaceful pursuits and adopt the profession of arms. Among these men was a well-known lawyer of New Haven in Connecticut, Gold Selleck Silliman by name. Lawyer Silliman became Brigadier-General Silliman. As the British troops advanced in the direction of New Haven the family of the General left their native place and settled in North Stratford, now called Trumbull. In this town Benjamin Silliman, the father of him whose death was recently recorded in these columns, was born in 1779.

Benjamin Silliman, sen., was a central figure in the group of pioneers of natural science in the United States. In 1818 he commenced the *American Journal of Science and Arts*, which continues to the present day to hold a leading position among the scientific journals of America. Two years before this date—that is, in 1816—Benjamin Silliman, jun., was born, at New Haven, where the Silliman family had so long had their home. The younger Silliman graduated at Yale College in 1837; and in the following year he began to teach chemistry, mineralogy, and geology. In 1846 he was appointed Professor of Applied Chemistry in the Sheffield Scientific School in connection with Yale College. The scientific work of Benjamin Silliman seems to have fairly begun about this time; according to the Royal Society's Catalogue, his first paper, "On the Use of Carbon in Grove's Battery," was published in 1842. From that time until his death he was an active worker in the advancement of science. During the years 1849-54 Silliman was Professor of Toxicology in the University of Louisville, Kentucky; in the latter year he returned to Yale College, to succeed his father as Professor of Chemistry. Here he remained until January 13 last, when he "went over to the majority."

Prof. Silliman did not publish any original memoirs, involving experimental work, of first-rate importance; like his father, he was distinguished rather as an organiser and teacher than as an investigator. For many years he acted as Secretary and Editor of the *Proceedings* to the American Association for the Advancement of Science. In 1838 he became associated with his father as joint editor of the *American Journal of Science*: in this capacity he exercised a great and beneficial influence in all matters connected with natural science in his own country.

The journal of which Sillimann was an editor contains about seventy papers from his pen; the greater number deal with mineralogical or chemico-mineralogical subjects, but he also wrote on such topics as glacier-motion, Australian wines, petroleum, temperature of flames, &c. He likewise furnished the *Journal* with many reviews of books and reports on the progress of various branches of natural science.

He published a book on the "First Principles of Chemistry," and another on the "Principles of Physics."

In his capacity as a public lecturer on scientific subjects, Silliman helped to guide the general opinion of his fellow-citizens in these matters in the right direction. It may indeed be said that his life-work was to form a connecting link between those who had devoted themselves to original investigation in natural science and the general outside world, which, while interested in science, requires a judicious and trustworthy middleman to interpret the meaning of the work that is being done for humanity by the students of nature in the inner shrine.

M. M. P. M.

MASAI LAND[1]

MR. THOMSON has not kept us waiting long for the story of his journey through a region of Africa which, so far as is known, had not previously been visited by any white man. Kilimanjaro itself was seen for the first time by Rebmann. After him Krapf, New, Von der Decken, Hildebrandt, and Wakefield, penetrated to the borders of the region which has been explored by Mr. Thomson, New alone being able to reach the snow-line on Kilimanjaro. Kenia, though doubtfully sighted by Krapf from afar, had never been approached. Mr. Thomson had thus a virgin field before him when he arrived at Zanzibar in the beginning of 1883, and the enterprise intrusted to him by the Royal Geographical Society he carried out in a manner and with results that will add much to the reputation which he achieved on his first expedition to Tanganyika. Mr. Thomson's instructions were to ascertain if a practicable direct route for European travellers exists through the Masai country from any one of the East African ports to Victoria Nyanza, and to examine Mount Kenia; to gather data for constructing as complete a map as possible in a preliminary survey; and to make all practicable observations regarding the meteorology, geology, natural history, and ethnology of the regions traversed. These objects Mr. Thomson never lost sight of, and, considering the means at his command, the time at his disposal, and the blackguardly crew he had to be content with as followers, are even more than might have been expected. Mr. Thomson is first of all a geologist, and no region in Africa is of more interest from a geological standpoint. He knows, moreover, enough of natural history to enable him to observe the flora and fauna of a country intelligently, and the value of his botanical collections has already been pointed out in our pages by Sir Joseph Hooker. For geographical observations he was even better fitted than in his previous expedition, and as for ethnology he found himself among a people unlike anything he had ever heard of in Africa, and in whom he took the intensest interest. Thus for the scientific reader the volume abounds with interest, and, as Mr. Thomson has no end of hunting and other stories of adventure to tell, his book is sure to be popular, especially as he is a skilful story-teller, abounding with a strong feeling of humour, or at least for the ludicrous, which does not spare even himself.

Mr. Thomson's route lay westwards from Mombassa to Kilimanjaro, which he traversed on nearly every side. Here he stayed for some time, ascending a considerable distance towards the Kimawenzi summit. For this magnificent mountain is really double-peaked, the highest summit, Kibo, reaching a height of over 18,610 feet, and Kimawenzi only about 2000 feet lower. The scenic features of the mountain were described in some detail in our columns recently in the paper read by Mr. Johnston at the Geographical Society, in which also its botanical and zoological characteristics were well brought out. Kilimanjaro, Mr. Thomson tells us, may be described as a great irregular, pear-shaped mass, with its major axis in a line running north-west and south-east, the tapering point running into the heart of the Masai country. On this line it is nearly sixty miles long. Its minor axis, running at right angles, reaches only to some thirty miles. The mountain is divided into the great central mass of Kibo and the lower conical peak of Kimawenzi. Towards the north-west it shades away into a long ridge, which gradually tapers horizontally and vertically till it becomes

[1] "Through Masai Land; a Journey of Exploration among the Snowclad Volcanic Mountains and Strange Tribes of Eastern Equatorial Africa." By Joseph Thomson, F.R.G.S. (London: Sampson Low and Co., 1885.)

merged in the Masai plain. As to the geological story of the mountain, Mr. Thomson works it out thus:—

"Let me try to trace the sequence of events which have produced Kilimanjaro. An examination tells us that in the serrated peak and rugged sides of Kimawenzi we see the original volcano, which, without doubt, existed long before there was a trace of its neighbour Kibo. Kimawenzi, after the imprisoned earth-forces found vent, rose in size and grandeur, added layer after layer to its height and circumference by a continual alternation of lava sheets and beds of agglomerate and tuff. It appears probable that it welled or belched out its contents without any of those terrific outbursts by which whole mountains are blown into the air or enormous areas submerged under a molten flood; for, curiously enough, we find no evidence that any of its lava-flows ever extended beyond the base of the mountain, or ashes accumulated to any depth in the surrounding country. At the present day the metamorphic rocks are seen to crop out at its very base on the east and south-east, and we have no reason to suppose that they ever were covered by lava rocks. As this—for a volcano—gentle accumulation went on, the hypogene agents would have more and difficulty in forcing the lava up the now elongated vent or orifice, and a time would come when the weight of the column would, in the end, balance the strength of the forces below. We can now imagine the terrible struggle that would ensue as the pent-up gases laboured mightily to relieve the pressure. Doubtless for a time they would succeed occasionally in clearing off the incubus and getting temporary outlet. At last even that would fail, and the volcano was doomed either to become extinct or find another vent. After some grand convulsions the latter was effected, and a new volcano began its existence to

Fig. 1.—Mount Kenia from the West.

the west of Kimawenzi. In process of time it soon rivalled its neighbour in size, and finally towered above it, battering Kimawenzi's hoary head—probably then snow-capped—with showers of stones, and even threatening to obliterate it under the volcanic ejections. Meanwhile Kimawenzi, now no longer under a reign of fire, with its volcanic life-work finished, began, like all things earthly, to crumble away before the slow-boring influence of apparently puny agents. Rain, snow, and frost worked on insidiously but steadily, and soon told their usual tale of denudation as they gradually loosened and washed away the loose ashes which formed the crater, undermined the more compact lavas, and hurled them to the bottom of the mountain; until finally the solid core which had originally choked the orifice stood out a shattered, weather-beaten pinnacle with only a slight indentation to mark the line of the original crater The beautiful concave curve, so characteristic of large volcanoes, is still to be seen from the east, and speaks of the once bandsome proportions of Kimawenzi.

"The fate which befell Kimawenzi soon came upon Kibo. A height was reached which baffled all the attempts of Vulcan to raise the lava to the surface, and, like the other, it became extinct. Evidently, however, the imprisoned forces had either spent their original strength, or they frittered away their terrible energies in the production of numerous parasitic or secondary cones, instead of uniting in another grand effort and producing a third great volcano.

"These cones were spread in great numbers all along the southern side of Kibo and Kimawenzi, and set themselves to the task of strengthening or buttressing them up. An enormous mass of lavas and agglomerates was belched forth, resulting eventually in the formation of what I have called the Chaga terrace or platform, and the long ridge which penetrates far into the Masai country.

These manifestations of volcanic energy were continued far into what, geologically speaking, are recent times, and the geologists may view the small cones in many instances as perfectly preserved as when they were at work.

"The most interesting relic of the reign of fire is presented by the beautiful crater lake of Chala, which lies a short distance to the east of the base of Kimawenzi, and only a few miles north of Taveta. It represents probably the latest manifestation of energy, extending indeed into historical times, as the natives have a tradition that at one time a great Masai village stood on its site and was blown into the air, and they will now tell you that at times you may still hear from its liquid depths the lowing of cattle and the bleating of sheep, as well as other village sounds. The shape of the lake is that of an irregular polygon, about two miles in diameter and little short of six miles in circumference. It occupies the centre of a small hill with very irregular rim, 400 feet

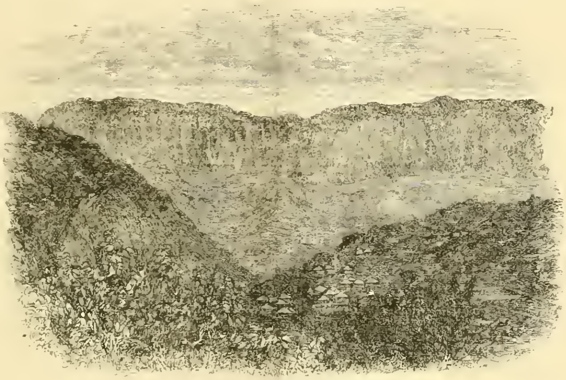


Fig. 2.—Lava Cap,' Elgeyo Escarpment.

above the eastern plain at its lowest point, and quite 800 at its highest, where it runs up into a peak. The outer slopes are formed by beds of lapilli and tuff, which incline away all around at the same angle as the hill itself. Internally the lake is bounded by perfectly perpendicular cliffs without a break at any point, at least as far as I could discover, though the natives of Taveta say there is a place where the descent can be made: indeed, its discoverer, New, declares that he reached the water, and drank of it. I went all around it, and though I am not deficient in enterprise or nerve, I saw no place where I dare descend, not even though I could have swung from creeper to creeper like a monkey."

From Kilimanjaro Mr. Thomson proceeded in a northerly direction, through the heart of the Masai country, to Lake Baringo, making a detour eastwards to

Fig. 3.—Glen of the Guaso Kamnyé.

Mount Kenia, which in some respects is even more interesting than Kilimanjaro. From Lake Baringo he proceeded as far westwards as the north-east shore of Victoria Nyanza, not many miles from the outlet of the Nile; then north to some strange artificial caves on the south face of Mount Elgon or Ligonyi (14,000 feet), and by Mount Chibcharagnani (12,000 feet), back to Baringo, and so south-eastwards to the coast, following a more northerly route after passing Lake Naivasha, which is just about half-way between Kilimanjaro and Lake Baringo, Of course this excellent piece of work was not accomplished without many trials and sufferings. The fierce and warlike Masai threatened many a time to eat Mr. Thomson and his men up, and it was only by the most wonderful tact and patience that the expedition succeeded in accomplishing its work without loss of life. The Masai

are notorious cattle-lifters and great breeders, but their herds were dying by thousands of some mysterious disease, and it was only when at its last gasp that an animal could be bought, its carcase when cut up being loathsome. It was no wonder, then, that Mr. Thomson suffered dreadfully from dysentery, and a less determined man might have succumbed entirely. Yet Mr. Thomson cannot sufficiently express his admiration for a people whom he regards as the Apollos of Africa. Their physique, their language, their habits, their bearing, differ entirely from those of any other African race, though there seems little doubt that they are, by language at least, allied to the Gallas. Indeed, their own traditions point to a Galla origin; they seem to be intruders into the region between Kilimanjaro and Kenia, which is now entirely dominated by them. They are certainly not a pure race, and scattered among them are remnants of a different people, who are the pariahs of the country. Their intelligence is above that of the average African, as is indicated by the dimensions of their skulls as well as by their organisation and general bearing. Their social habits are much what we find among other races of their stage of civilisation; "morality"

FIG. 4.—*Acelaphus Cokii.*

begins only after marriage. All the unmarried men belong to the warrior class, and are permitted to use none other than animal food. Their spears, of native make, are of enormous dimensions, and their war costume is elaborately ludicrous. One strange custom is that spitting is the greatest mark of distinction you can bestow upon a Masai, and Mr. Thomson was often sorely exercised when he desired to be particularly conciliating and gracious in his intentions. This custom is, however, not without parallel: the natives of part of the southern coast of New Guinea, indeed, improve upon it by squirting mouthfuls of water on those to whom they wish to give a specially friendly welcome. What is the particular significance of the custom perhaps those who have investigated the subject of salutations may be able to explain.

As to the country itself through which Mr. Thomson passed, while part of it is desert, simply from want of water, much of it is rich in grass and forest, abundantly watered, and with a wealth of varied scenery scarcely surpassed in some of the favourite tourist resorts of Europe. Besides the two prominent mountain summits, there are several ranges of varying height, one of the loftiest and most attractive being to the south-west of Mount Kenia, and to which Mr. Thomson loyally gave the name of Lord Aberdare. "The Masai country," Mr. Thomson tells us, "is very markedly divided into two quite distinct regions, the southerly or lower desert area, and the northerly or plateau region. The southerly is comparatively low in altitude, that is to say, from 3000 to nearly 4000 feet. It is sterile and unproductive in the extreme. This is owing, not to a barren soil, but to the scantiness of the rainfall, which for about three months in the year barely gives sufficient sustenance to scattered tufts of grass. The acacia and mimosa have almost sole possession of those dreary plains, except near the base of some isolated mountain or other highland, where small rivulets trickle down, to be speedily absorbed in the arid sands. No river traverses this region, and many parts are covered with incrustations of natron, left by the evaporation of salt-charged springs. We have seen something of this lower region in the flat reach of Njiri, and the forbidding desert of Dogilani. It is not, however, to be conceived as a monotonous level. Far from it. The colossal Kilimanjaro and the conical Mount Meru belong to it. The hills of Gelĕi and the Guaso N'Ebor circle round in the form of an amphitheatre, to meet the metamorphic masses of Ndapduk and Donyo Erok. Further to the west and north are the volcanic masses of Donyo Engăi, Donyo la Nyuki, and Donyo Logonot, with the hills of Nguru-ma-ni. Except in the immediate vicinity of the higher mountains, such as Mount Meru and Donyo Engăi, the country is to a large extent uninhabited. To summarise this tract we may say that it is triangular in general shape, the apex towards the north reaching to within thirty miles of the equator, and extending beyond to Baringo as a species of trough or deep irregular cutting. The Masai are only to be found at all seasons about such favourable situations as the base of Kilimanjaro, Mount Meru, Ndapduk, Gelĕi, Kisongo, to the west of Meru, Donyo Engăi, and along the edge of the plain at the bases of the bordering highlands Maŭ and Kaptè. The country is sufficiently characterised when the fact is stated that it is a region of later volcanic activity, which in a very recent geological period has produced the cones and craters already referred to. These results of volcanic energy may, to some extent, be accounted for—though the statement may seem to savour of reasoning in a circle—by the lower region as an area of depression having subsided or sunk from the higher level of the flanking table-lands. The northerly or higher plateau region of Masai Land may be described as rising from an elevation of nearly 5000 feet on either side, and culminating in the centre at an elevation of little short of 9000 feet—although through this very line of highest elevation runs from the Dogilani plain the remarkable meridional trough which incloses the charming chain of isolated lakes, Naivasha, Elmeteita, Nakuro, and Baringo; and which, at the last-named place, begins to widen out till it assumes the characteristics of the southerly plain of Masai Land. On the eastern half of this divided plateau rises, as we have seen, the snow-clad peak of Kenia—and the picturesque range of the Aberdare Mountains, which runs almost parallel with the central line of depression. A more charming region is probably not to be found in all Africa, probably not even in Abyssinia. Though lying at a general elevation of 6000 feet it is not mountainous, but extends out in billowy, swelling reaches, and is characterised by everything that makes a pleasing landscape. Here are dense patches of flowering shrubs; there noble forests. Now you traverse a park-like country enlivened by groups of game; anon, great herds of cattle, or flocks of sheep and goats are seen wandering knee-deep in the splendid pasture. There is little in the aspect of the country to suggest the popular idea of the tropics. The eye rests upon coniferous trees, forming pine-like woods, and you can gather sprigs of heath, sweet scented clover, anemone, and other familiar forms. In vain you look for the graceful palm—ever present in the mental pictures of the untravelled traveller. The country is a

very network of babbling brooks and streams—those of Lykipia forming the mysterious Guaso Nyiro; those of Kikuyu the Tana, which flows to the Indian Ocean through the Galla country; while further, south, in Kaptè the streams converge to form the Athi River, which flows through U-kambani to the Sabaki River."

Here is Mr. Thomson's account of his observations on Mount Kenia:—"We were now at an altitude of 5700 feet, which may be taken as the general level of the plain from which Mount Kenia rises. Kenia itself is clearly of volcanic origin, and may be considered to be a counterpart of the Kimawenzi peak of Kilimanjaro. Unlike Kilimanjaro, its volcanic forces have not changed their focus of activity, and hence it now stands as a simple undivided cone. Up to a height of 15,000 feet (9000 feet above the plain) the angle of slope is extremely low, being in fact only between 10° and 12°, a fact which would seem to show that the lavas ejected must have been in a much more liquid condition than those of Kilimanjaro. The angle in the latter is much higher, indicating that the ejections were more viscid, and consequently did not flow so far from the orifice. At an elevation of over 15,000 feet the mountain suddenly springs at a high angle into a a sugar-loaf peak, which adds a further height of about 3400 feet. At the base of the peak two small excrescences are noticeable, and some distance to the north there rises a humpy mass. This peak, as in the case of Kimawenzi, without a doubt represents the column of lava which closed the volcanic life of the mountain, plugging or sealing up the troubled spirits of the earth. The crater has been gradually washed away—having been composed, doubtless, of loose ashes and beds of lava, and now the plug stands forth, a fitting pinnacle to the majestic mass below. As at Kilimanjaro, nature has appropriately woven for its grim head a soft crown of eternal snow, the cool, calm shining of which is at once a wonderful contrast and a strange close to the mountain's fiery history. The sides of this upper peak are so steep and precipitous that on many places the snow is quite unable to lie, and in consequence the rocks appear here and there as black spots in the white mantle. Hence its Masai name of Donyo Egèrè (the speckled or gray mountain). The snow covers the whole of the upper peak, and extends some distance on either side, reaching, and indeed including, the humpy mass on the north. The peak is strikingly suggestive of an enormous white crystal or stalagmite, set upon a sooty basement, which falls away gradually into the dark emerald green of the forest region round the base."

On the north side of Mount Kenia very few streams have their origin, though on the south side they are said to be abundant. It is still more unaccountable that, except on the south side of Mount Kilimanjaro, not a stream trickles down the snow-capped mountain, a phenomenon which only actual exploration can account for. One of our illustrations (Fig. 2) shows a great lava-cap in the Elgeyo Mountains to the west of Lake Baringo. In a running survey such as Mr. Thomson made, minute observation is of course impossible; but with his experience as a field geologist and his general caution, we may accept his geological map of the region lying between Victoria Nyanza and the coast as in a general way representative of the facts. Along the coast at Mombassa we find a strip of Tertiary rocks, succeeded westwards by a broad band of Carboniferous. West and north west of this is a great area of metamorphic rocks, having their counterpart further westwards on the east side of Victoria Nyanza. Between them, in three irregular strips, lie the earlier and later volcanic series, the mass of Kilimanjaro winding its way into the metamorphic, and Kenia lying on the northern edge of the latter. That volcanic activity is not quite extinct is shown by the fact that in the Kenia region hot springs and pools are met with, and the natives have a tradition that on the site of Lake Chala, on the east side of Kilimanjaro, once stood a large and populous town.

Thus Mr. Thomson has been able to fill up in a very satisfactory manner a considerable blank on the map of Africa. He has moreover established the fact that Baringo is a distinct lake, and that the east shore of Victoria Nyanza trends much more to the north-west than we find it on Mr. Stanley's map. The combined observations of Mr. Thomson and Mr. Johnston are a valuable addition to a scientific knowledge of one of the most interesting regions of Africa.

NOTES

Many of our readers will be pleased to learn that M. Charles Feil has, after some years' absence, returned to the active management of his celebrated manufactory of optical glass in Paris, the new firm being "Feil père et Mautois." M. Charles Feil, who is well known both for his scientific and business abilities, is grandson to M. Guinaud, who, some sixty years since, in a mode of working almost identical with that adopted by the celebrated potter Palissy, overcame the serious obstacles which occur in securing the perfect homogeneity of both crown and flint glass, and whose secrets have descended to his grandson.

It is with great regret we announce the death, on the 7th inst., of Mr. Edward Caldwell Rye, Librarian to the Royal Geographical Society, after a very short illness, from small-pox, aged about fifty-two years. In natural history he specially made his mark as an entomologist, and for a long time was the chief authority on British beetles, on which subject he was the author of a volume in Lovell Reeve and Co.'s series of popular works on British Natural History. For several years he contributed the article "Coleoptera" to the *Entomologists' Annual*, and he was one of the editors of the *Entomologists' Monthly Magazine* from its commencement in 1864. Furthermore he was for some years on the staff of the *Zoological Record* as a contributor, and since the 10th volume of that useful publication he had been sole editor. Nowhere will his nearly sudden death be more felt than at the Royal Geographical Society, for, in addition to his ordinary duties as Librarian, that of editing the bibliographical portion of the *Proceedings* devolved upon him. Mr. Rye married a daughter of Mr. G. R. Waterhouse, of the British Museum, who, with four children, all young, survives him; and, if report be true, they are left almost unprovided for. He was a Fellow of the Zoological Society, a member of the Entomological Society of London, and the Recording Secretary of Section E at the meetings of the British Association.

We regret to announce the death, at Paris, on February 1, at the early age of thirty-four, of Mr. Sidney Gilchrist Thomas, to whom is mainly due the basic Bessemer process. Born in 1850, he entered the Civil Service, but from his youth showed a taste for science, and especially metallurgy. The project of eliminating phosphorus by the Bessemer converter soon occupied all his attention, and, after numerous experiments at Blaenavon, in 1877 he took out his first patent, and communicated his invention to the Iron and Steel Institute in a paper read at the Paris meeting in 1878.

The Minister of Agriculture in Canada has just declared the Bell telephone patent void in the Dominion, the occasion being a double infraction of the Canadian law by the Canadian Telephone Company. It appears that the Company imported telephones after the expiry of two years from the date of the patent, and that it also refused to sell instruments to the public, demanding annual rentals for the lease, as in this country and in the States. Both these acts contravene the Dominion law.

UNDER the title of "The Cost of a Fog," Mr. W. T. Makins, Governor of the Gas Light and Coke Company, writes to the *Times* under date of January 24:—"Perhaps your readers may be interested to read the experience of the Gas Light and Coke Company on the occasion of last Tuesday's fog. Ninety-six million cubic feet of gas were sent out during the twenty-four hours ending at midnight on Tuesday. This quantity was an increase on that of the corresponding day in 1884, which may be taken to have been an ordinary January day, of 37 per cent., or over 35,000,000 feet. The price being 3*s.* per 1000 feet, the public had to pay this one company 5250*l.* extra on account of the fog. Nine thousand five hundred tons of coal were carbonised during the twenty-four hours to produce the 96,000,000 feet, the largest quantity we have ever sent out in one day."

THE *Times* Alexandria correspondent, in reference to the Egyptian Sanitary Board, takes occasion to mention the immense services which might be rendered to that country and to science by the appointment of a scientific microscopist and analyst to the uncontrolled charge of the Health Department. An eminent physician assures him that half the population are mentally and physically incapacitated for work, owing to the existence of certain diseases, which sanitary study might remedy.

FOLLOWING the example of the United States Geological Survey, that of Canada has lately enlarged the sphere of its operations, so as to include ethnological work in its publications. The first result of this wise measure is a volume containing copious comparative vocabularies of the chief Indian languages still current in British Columbia, for which the authors, W. Fraser Tolmie and George M. Dawson, have been collecting materials since the year 1875. In this collection, which was issued in 1884 by Dawson Brothers of Montreal, the list of words proposed by Mr. Gibbs in his "Instructions for Research Relative to the Ethnology and Philology of America," has been adopted as a basis, and his orthographic system has also been largely adhered to. The vocabularies thus comprise over 200 words of one or more dialects of every stock language spoken on the Pacific slope of the Rocky Mountains from Alaska southwards to the Columbia River. Appendices are added containing comparative tables of other native languages from vocabularies already printed, and from these tables it appears evident that, contrary to the hitherto prevalent impression, the widespread Tinné (Athabascan) family is represented on the Pacific slope in the Tshimsian group about the Nasse and Skeena rivers over against the Queen Charlotte Islands. Nevertheless on the accompanying linguistic map, which is on a large scale, this group is still coloured separately as if it were a stock language, and not a branch of the Athabascan, as is now for the first time made evident. The other stock languages of this region—Haida (Queen Charlotte Islands), Thlinkit (from Alaska to the Nasse River), Kwakiool, Aht, and Kawitshin (Vancouver Island), Niskwalli (Puget Sound), Cheheili (Washington Territory), Tshinook (Lower Columbia River), Bilhoola (Bentinck and Dean Inlets), Selish (Fraser River), Sahaptin (Right Bank Columbia River), and Kootenuha (Kootenay and Upper Columbia Rivers)—all are represented in one or more of their branches. Altogether valuable materials are here collected and conveniently arranged for the comparative study of nearly thirty languages or distinct dialects current in one of the most intricate linguistic domains on the American Continent.

THE African Association will shortly send to the Congo the apparatus required for establishing telephonic communications between certain stations on the lower river.

ACCORDING to the report of Capt. E. Backhaus, of the German ship *Carl* (published in *Hansa*), that vessel, while on her voyage from New York to Trieste, experienced an earthquake at sea on the night of December 21–22 last. For about five minutes the ship was violently shaken. The lamp shades were thrown to the ground, and the upper layers of the tins of petroleum between decks were pitched up against the deck. She was then at 36° 34′ N. lat. and 22° 26′ E. of Greenwich, that is, near Cape Matapan in the south of Greece. Those on board thought the ship had struck on a rock, and the pumps were rigged and set working. The sea was still, but had a whitish colour; the wind was east and light, and the rate was about three nautical miles per hour. When examination was made subsequently, no trace of injury was found on the wood or copper outside. The captain was led to make a report of the occurrence at Trieste by hearing of the Spanish earthquake, as well as from another shipmaster, who had experienced the same phenomenon also to the south of Greece.

THE last four years have been a period of unusual activity in railway construction in Japan. How much has been done in that period, and is now being done, is not generally understood in Europe. The following statement on the subject is summarised from a paper communicated to the Geographical Society of Toulouse by Capt. Fouqué, Professor of Mathematics in Tokio. The line between Tokio and Yokohama, eighteen miles in length, was opened in June, 1872; that between Hiogo and Osaka in March, 1874, its extension to Kioto in 1876, and a further extension to Otsu, making the total length from Hiogo about sixty miles, in 1879. At Otsu it reached the shores of Lake Biwa. What may be regarded, therefore, as a prolongation of this line is that from Nagahama, at the head of the lake, to Tsuruga, an important harbour on the sea of Japan, a distance of over twenty-five miles. There is thus a direct steam connection (as there is a fleet of steamers on the lake) between Hiogo on the Inland Sea, and the Sea of Japan on the west. On May 25 last a line was finished between the same—Nagahama and Sekigahara—with a continuation to Ôgaki, a total distance of about fifty-five miles, through the centre of the province of Mino, one of the most productive in Japan. The last line finished is that between Tokio and Tagasaki, which was opened by the Emperor on June 25, 1884. The length is about sixty-two miles, and it taps the rich provinces of Josbin, Shinshin, and Boshin, the great centres of silk, tea, and tobacco cultivation. There were no serious engineering difficulties on this line, perhaps the most important of any yet constructed in Japan, for it traversed large and fertile plains. Thus the total length of the railways actually constructed in Japan is about twenty-three miles. Two short lines in course of construction are those between Shinagawa, near Tokio, and Kawaguchi, and one from Tagasaki to Mayebashi, the capital of the silk trade. The latter is only about eight miles long, and may be regarded as complete. Of projected lines the construction of the following have been decided on, and the work should be commenced by this time: (1) one from Tokio due north through the centre of the main island to Awomori, opposite Hakodate, in the Island of Jezo. This would be one of the main trunk lines of Japan, and its length will be about 450 English miles. (2) From Takasaki to Ôgatchi, the first part of a line which will ultimately reach Yokkaichi, an important seaport on Owari Gulf, on the east coast. The length of this will be about 200 miles. (3) From Nyeda, in Shinano province (in the centre of the main island) to Niigata, the principal part of the west coast, 150 miles, and two shorter lines intended to connect important towns with neighbouring ports. It has been decided recently to construct tramways between some of the principal towns omitted in the railway scheme, the first being between Tokio and Kofu, a distance of about 700 miles. The amount of money available for public works of this description is necessarily limited, and the progress is therefore, everything considered, exceedingly rapid.

According to a Russian journal, quoted in *Globus*, the Russian law, especially as regards murders, is now to be enforced amongst all natives under Russian rule. Hitherto the murder of a Kirghiz was punished by their own customs in the following manner:—When in an aul or in the steppe a murder has been committed, the relatives and friends of the dead man commence the search for the murderer. Sometimes he is not found until after a long interval, especially if the body is not soon found. Frequently the latter is hidden, then the flight of birds of prey is watched, and other indications are utilised by the extraordinary acuteness of the nomads. When the murderer is discovered the relations have the right to levy from him a so-called *kun*. This fine, which washes away bloodguiltiness, consists of a number of camels, horses, sheep, and clothes, a special *kun* being due to those who took part in the search for the murderer, to the person who actually discovered him, and to the judge. The fine, or *wergild*, for a woman is less than that for a man, and in the latter case it varies with the descent. Thus there would be a greater fine for killing a pure Kirghiz than for killing one whose descent was unknown. If the murderer cannot pay the *kun*, his kinsfolk must do it for him, and the payment and receipt of this fine is accompanied by a number of different customs. The occasion is a kind of festival in the aul in which the relatives of the murdered man live. Among the animals paid as *kun*, the murderer's horse must always be one. The family of the person killed have, however, the right to refuse all payment, and to demand a duel with the slayer. The latter appears in the aul of the others armed from head to foot, and mounted on his best steed; a certain distance off the avengers are stationed, and a wild race ensues. If the accused can get away from his pursuers, he is safe from all punishment; he can, however, only be pursued to the going down of the sun, and directly the latter sinks behind the horizon he is free. If he is caught he is generally put to death at once. It is remarkable that a murder rarely remains undiscovered. The Kirghiz hardly ever commit that crime for the sake of robbery; the murder generally takes place after a quarrel, or for revenge.

Among the various contrivances for indicating 24 hours on watch dials, one by Sturrock and Meek, mentioned in the February number of the *Horological Journal*, seems to be neat and ingenious. The dial is made with twelve holes in place of the usual figures. During the first half of the day, midnight to noon, the figures 1 to 12, placed on a disk at the back, show through; at noon the disk becomes automatically shifted so that the figures 1 to 12 are replaced by figures 13 to 24 (0); at midnight the figures 1 to 12 are again brought into view. Thus, whilst retaining the ordinary and familiar and convenient 12 hour spaces, the advantage of the 24-hour system is obtained without the necessity of keeping a double set of hourly figures constantly in view.

To the *Boletin de la Institucion libre de Enseñanza* for January 15, D. Augusto Arcimis sends an account of the meteorological branch of the observatory recently attached to that institution. The building is situated in the Paseo del Obelisco in the north of the city, where it is surrounded only by low buildings and removed as far as possible from disturbing influences. Pending the acquisition of improved instruments a mercurial barometer connected with two thermometers, and with a diameter of 4 mm., has been set up, and since last December its readings have been systematically compared with those of the barometer in the Medical Observatory. With another instrument, specially constructed by Salleron of Paris, records are taken of the atmospheric temperature in the shade, as well as of the moisture, certain modifications having converted it for practical purposes into a hygrometer similar in principle to that of Mason. The thermometer of maxima is modelled on the system introduced by Negretti and Zambra of London, while that of minima adopts the Rutherford system, both being manufactured by Secretan of Paris. To avoid as far as possible the disturbing influences to which all meteorological stations are exposed in large cities, the instruments are placed in wooden boxes, which, while exposed to the free circulation of the air, are still thoroughly protected from bad weather and from the direct rays of the sun. The Institution has also been supplied with other instruments for determining the amount of evaporation, the loss of heat by radiation, the force, pressure, and direction of the winds prevalent throughout the year. This meteorological station is thus one of the best equipped in Europe, and in fitting it up advantage has been taken of the experience already acquired from the working of similar establishments elsewhere.

The first railway in Cochin-China was opened on December 21 last. It runs from Saigon to Mytho, the journey taking about four hours.

In connection with the Parkes Museum a meeting will be held at the Mansion House on Friday at 3 p.m. to obtain more extended support for the Parkes Museum, so that it may be firmly established on a permanent basis. The Right Hon. the Lord Mayor will preside, and the Council hope to have the support of all those interested in promoting public health and a knowledge of the laws of hygiene.

At the Meeting of the Council of the National Smoke Abatement Institution, preliminary to the recent annual meeting, a letter was read from the secretary of the Duke of Westminster stating that in his Grace's town house nothing had been burnt but coke, with the most satisfactory results. The Draft Report to the Annual Meeting was presented by the Secretary, to which, at the chairman's suggestion, it was decided to add a paragraph calling attention to the obsolete character of the boundaries within which the present Metropolitan Smoke Act is operative, and pointing out the necessity for a short amendment Act aiming at a rectification of the boundaries, and the necessity for a firmer and fuller application of the provisions of the Act to certain industries in which smoke abatement is now much easier than it was at the time when the present Act was passed. It was resolved to communicate with the Home Secretary, calling his attention to the documents which had been already forwarded to him, and to the paragraphs in the Report relating to the nominal nature of the fines imposed by the magistrates in cases of infringement of the Act, and ask him whether, under the circumstances, he would be willing to issue a circular calling the attention of the police magistrates to the evils which result from the difficulty of obtaining a due enforcement of the law. It was further resolved to issue a separate memorandum, in the form of a leaflet, putting forward some information as to the conditions to be considered in the choice of grates, in the burning of fuel, and in the general treatment of a coal fire.

Prof. Sidney Colvin, Slade Professor of Fine Art in the University of Cambridge, will give two lectures at the Royal Institution, on Tuesdays, February 17 and 24, on "Museums and National Education."

Some of the fish in the Salmonidæ tank at the South Kensington Aquarium have recently been spawned, the species operated upon being the *S. levenensis*, *S. fontinalis*, and the *Gilleroo* trout of Ireland. The eggs have been deposited in suitable hatching boxes, where they afford satisfactory evidence of ultimate success. It will be particularly interesting and edifying to note the result on account of the prolonged captivity of the fishes from which the eggs were spawned.

The fine aquarium on view during the Health Exhibition will naturally be in existence during the forthcoming Inventions Exhibition. In addition thereto will be shown a very large collec

tion of fish culture appliances showing the process of hatching, the mode of dealing with the fry after losing their umbilical sac, and the best means of artificially feeding them until they have reached that stage in their existence when they are able to provide for themselves. A special building is to be erected for this purpose in proximity to the aquarium, which is now in course of construction. This section of the Exhibition, which will be under the entire direction of the National Fish Culture Association, promises to be a source of much attraction and interest to the ichthyological world.

An experiment has lately been tried by the Secretary of the National Fish Culture Association at South Kensington to test the highest temperature endurable by various species of fish. To this end several specimens of the following fish were selected for the trial, viz. the carp, gudgeon, dace, roach, perch, minnow, golden tench, common tench, trout, and salmon, all of which were deposited in cold water registering 53°. The temperature was then gradually increased by the infusion of hot water through a tube which caused the temperature to rise steadily. None of the fish, however, exhibited signs of fading vitality until the thermometer recorded 82°, when a perch became prostrated; and shortly afterwards its congeners followed its example in rapid succession in the following order:—Roach, 82½°; salmon, 83°; minnow, 85°; gudgeon, 85½°; dace, 86°; common tench, 88°; golden tench, 88°; carp, 91°.

So as to further test the efficacy of brandy as a fish restorer, about which much has lately been said, each fish on showing signs of exhaustion was removed from the water, dosed with a small quantity of brandy, and replaced in the tanks from whence it was taken. The operation proved highly successful, for on inspection the following day all the objects of the experiment were found swimming about as usual, and thoroughly restored to their normal exuberance, with the exception of the dace, which succumbed to the severe ordeal through which it had passed.

The additions to the Zoological Society's Gardens during the past week include a Green Monkey (*Cercopithecus callitrichus*) from West Africa, presented by Mr. F. W. Robinson; a Royal Python (*Python regius*) from West Africa, presented by Mr. A. H. Berthoud; a Long-eared Owl (*Asio otus*), British, presented by Mr. R. Farren; two Kagus (*Rhinochetus jubatus*) from New Caledonia, purchased.

GEOGRAPHICAL NOTES

In a special article communicated to the *New York Tribune*, Lieut. Greely unfolds his views upon future Arctic exploration. Of the five well-known routes to the Pole, he advocates the Franz Josef route as the only probable one. Lieut. Greely shows by all the experiences of Arctic travellers, from Sir Edward Parry downwards, that continuity of land, with northern trend and western aspect, and a secure harbour easy of access, together with good ice for sledging operations, are necessary desiderata for Arctic exploration. He maintains that all these conditions are fulfilled in the fifth route—viz. that by Franz Josef Land. "This route," continues Lieut. Greely, "presents unusual chances of success with the minimum of danger. It is more than possible that an English expedition will enter these waters. Chief Engineer Melville, U.S.N., has in view an expedition by this route, and his varied Arctic experiences and indefatigable energy mark him as a man peculiarly fitted for this work. It is therefore to be hoped that he will be given the desired opportunity. Two ships with about sixty men and officers would be needed. One vessel should winter in Eira Harbour or some secure point near by, while the second should be pushed as far northward as possible, preferably by Austria and Rawlinson's Sounds, but, if that is not possible, along the west coast of Franz Josef Land beyond Cape Ludlow. The vessels should be provisioned for three years, and the crews should be quartered in temporary houses to be erected on shore. August and September there, as in Smith Sound, are undoubtedly the most favourable months for ice navigation. In case of a bad year for ice the vessels should rather return, to renew the expedition the year following, than adventure the experiences of the *Tegethoff*. After full suggestions and recommendations as to the command and outfit of the expedition, covering every branch of the subject, the writer expresses a doubt whether the United States Government will extend any aid to Arctic exploration for years to come, but none the less does he believe in the propriety and certainty of future Arctic work. In concluding his article Lieut. Greely says:—"The expedition suggested by Lieut. Ray, United States Army, at the meeting of the British Association at Montreal, should receive the attention and support of scientific men. The magnetic pole of Boothia Felix Land, located by Ross in 1831, has probably changed its position in the past fifty years. Its re-location would be an important contribution to science. With a home station at Repulse Bay or in Wager River, I believe this work could be done without great expense or serious danger. The benefits to be derived from such an expedition would not be confined to terrestrial magnetism. As regards ethnology, botany, and natural history, the country around King William Land is substantially a blank."

An interesting account of recent Norwegian explorations in the Spitzbergen Seas will be found in yesterday's *Times*. Several new islands have been discovered to the east of King Karl or Wiche Land. These explorations show that the year 1884 was a very remarkable ice-year. The west side of Spitzbergen was blocked by a belt of land-ice the whole summer through, while the east side, which is nearly always blocked with ice, was more open than it has been for many years. These conditions, there seems little doubt, depend on the prevailing direction of the winds.

According to the *American Naturalist* three expeditions have been despatched during the last summer to explore the lake region reported to exist in the north-eastern part of the provinces of Quebec and in Labrador. One went by way of Lake St. John, another by the River Betsiamits, and a third from Newfoundland. The last has orders to land scientific observers at various points upon the coast of Labrador, where they will spend the winter. Little that is definite appears to be as yet known respecting the actual dimensions of Lake Mistassini and other bodies of water in this region. A French missionary, writing in 1672, says that this lake is "believed to be so large that it took twenty days to walk around it." Mr. Burgess affirms that it is 150 miles in length, and abounds in deep bogs. An old trader of the "Compagnie des Postes du Roi," who was stationed on it for several years, estimated its least width at ninety miles. The account of 1672 mentions another lake, "ten days' round, and surrounded by lofty mountains." These lakes appear to occupy a depression similar to that occupied by Lakes St. John, Temiscaming, and many smaller lakes to the southward, and Silurian limestone has been observed in Lake Mistassini as well as at Lake St. John. The former lake is supposed to be about 1300 feet above the sea, and the land between it and Lake St. John to the south is only 300 feet above the sea. The plain around it is said to be very fertile, and attention has recently been called to the magnificent forests and fertile soil of the country around Hudson's Bay to the north of it. The explorations now in progress will doubtless open up extensive areas for colonisation, besides adding largely to our geographical knowledge.

La Gazette Géographique announces the death, in Tonquin, of M. Stocker, who perished recently in an expedition against the Muongs on the Red River. M. Stocker, who was a native of Alsace, travelled for thirty years in the United States, having explored specially the Rocky Mountains and the territory of Alaska. He returned recently from California to France, and was despatched by the Government to investigate the mineral wealth of Tonquin, where he discovered the auriferous deposits of Myduc. His reports on the subject were not encouraging for the development of mining enterprise there, as he declared that the value of the mines had been greatly exaggerated. He was shot dead during one of the skirmishes in the Muong expedition.

Sixteen "*brigades topographiques*" embarked at Marseilles on January 31, fourteen for service in Algeria and two in Tunis. These brigades are under the command of an officer, of an engineer, and of an official of the geographical department of the War Office in Paris. The whole include seventy-two officers, each accompanied by two soldiers and a native sharpshooter.

The instruments, provisions, and tents for each officer are to be conveyed on a horse and four mules. They will commence their surveying work in the south of each of the three Algerian provinces, and their position, scattered as they will be singly over the whole of Algeria, in the midst of semi-subjugated tribes, will be a delicate and perilous one. They will probably return to Paris about the end of May.

At the last meeting of the Geographical Society of Paris it was stated that Col. Prejevalski had discovered the sources of the Yang-tsze-kiang.

The last number of the *Boletin de la Sociedad Geográfica de Madrid* contains a first instalment of Capt. Eduardo O'Connor's official report on his recent exploration of the Upper Limay (Rio Negro) and Lake Nahuel-Hualpi. This report is of considerable geographical interest, as it embodies a detailed account of the first successful attempt to navigate the Rio Negro, from its mouth in the Atlantic to its source in the romantic Lake Nahuel-Hualpi in the heart of the Chilian Andes. As far as the Colluncurá (Catapuliche) confluence the expedition was able to proceed on board the *Rio Negro* steamer, but beyond that point it had to make its way in an open boat, which had in many places to be hauled over the numerous rapids obstructing the navigation of the Upper Limay, or furthest southern head-stream of the Rio Negro. Here the river flowed mainly in a narrow rocky bed, contracting at some points to 120 and even 100 feet, with a current varying from seven to nine, and even eleven miles an hour at the most difficult rapids. But beyond the confluence of the Treful, in 40 42′ S. lat., the reefs and other obstructions disappeared, the current fell to a mean velocity of five or six miles, and as the stream is very deep it would be accessible to steam launches in this section all the way to the lake. Approached from the Limay this alpine basin presented a charming prospect, winding away to the right in an endless series of rocky inlets or wooded creeks, opening out to the left in broad and slightly undulating grassy savannahs. The hills rise in some places to a height of 700 or 800 feet above the lower wooded slopes, breaking into sharp peaks, crags of fantastic shape, or rocky walls, assuming here and there the appearance of cyclopean fortifications. The horizon was bounded in the distance by an extensive range of lofty sierras covered with snow, and like the lower hills often assuming the most varied and capricious forms. The deep blue waters of the lake are broken only by a solitary island of large size covered with dense vegetation, and intersected by regular ranges of hills from 300 to 400 feet high. The surrounding country appears to be uninhabited, and on calm days, rare in this breezy region, all nature is wrapped in the stillness of death, and the glassy surface of the lake unbroken by a single ripple.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *FEBRUARY* 15-21

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 15

Sun rises, 7h. 16m. ; souths, 12h. 14m. 20·3s. ; sets, 17h. 13m. ; decl. on meridian, 12° 30′ S. : Sidereal Time at Sunset, 2h. 56m.

Moon (New at 2h.) rises, 7h. 6m. ; souths, 12h. 29m. ; sets, 18h. 0m. ; decl. on meridian, 8° 9′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on Meridian
Mercury	6 44	11 1	15 17	19 47 S.
Venus	6 36	10 57	15 18	19 5 S.
Mars	7 20	12 12	17 4	13 49 S.
Jupiter	17 28*	0 35	7 42	12 8 N.
Saturn	11 18	19 21	3 25*	21 34 N.

* Indicates that the rising is that of the preceding, and the setting that of the following nominal day.

Occultation of Star by the Moon

Feb.	Star	Mag	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
20	38 Arietis	5	19 41	20 1	211 246

Phenomena of Jupiter's Satellites

Feb.	h. m.		Feb.	h. m.	
16	6 20	I. ecl. disap.	19	0 25	I. tr. egr.
	19 21	III. ecl. disap.		19 15	I. occ. disap.
	23 9	III. occ. reap.		20 41	IV. ecl. reap.
17	3 40	I. tr. ing.		21 34	I. occ. reap.
	6 0	I. tr. egr.		23 38	II. tr. ing.
18	0 49	I. ecl. disap.	20	2 33	II. tr. egr.
	3 8	I. occ. reap.		18 51	I. tr. egr.
	5 22	II. ecl. disap.	21	18 32	II. occ. disap.
	22 6	I. tr. ing.		21 33	II. ecl. reap.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich

Feb.	h.	
15	4	Mars in conjunction with and 4° 30′ south of the Moon.
17	1	Saturn stationary.
19	8	Jupiter in opposition to the Sun.

CATALOGUE OF EARTHQUAKES[1]

THE importance of earthquakes as factors in geology tends to be more and more appreciated, and the seemingly increased seismic activity so strongly manifested in different quarters of the globe during the last few years has greatly stimulated the interest in, and the study of, these wonderful phenomena. Amongst many contributions to this branch of geology, have appeared quite recently, this catalogue and map, of which we have given the title, and which have followed other papers by the same author relative to this series of phenomena, published in the *Proceedings* of the Royal Irish Academy.

The earthquake catalogue and map now given by Prof. O'Reilly is based upon a very interesting relation of jointing and fissuring to the physical geography of a country, but more particularly to the coast-line directions. This relation he has shown to be very marked for the east coast of Ireland (see *Proc. Roy. I. Acad.*, 2nd series, vol. iii. ; *Science*, No. 8, May, 1882, and vol. iv. ; *Science*, No. 2, 1884) ; and, considering that much of the fissuring of the earth-surface is mainly due to earthquake action, he looks upon the systems of jointing and fissuring of a country, and consequently their correlated coast-lines, as so many records of past earthquake action ; the only ones, in fact, left us in many cases, and (taking into consideration the poverty and meagreness of historical records in this respect) the most valuable records of these phenomena we have extant. On the other hand, the lists of Mallet, Perrey, Fuchs, &c., present earthquakes in a purely chronological order, are difficult to consult and but little accessible, and in them the events stand out independently, and to a very great extent without apparent connection one with the other, while we know that geological change is the result of a sum of actions taking place continuously in certain localities, and extending through immense durations of time. It has seemed to the author of the present "Catalogue" that it would be useful to present the earthquakes of the three kingdoms in a summarised and connected form, and for that purpose arranged alphabetically, so that it may be possible to ascertain for a given point or locality the sum of earthquake action having occurred therein during historical time. The "Catalogue" thus formed merely gives the years of occurrence for a given place or district, and in this manner indicates frequency of occurrence sufficiently, while serving at the same time as a sort of year and place index for the larger collections. From it he has been able to represent graphically the distribution of earthquakes over the three kingdoms by adopting conventional tints and marks to indicate extent of action and frequency of occurrence, the only factors which it is possible at present to so represent.

From this map it would appear that Great Britain has been much more subject to shocks than Ireland during the period embraced by the records. That as regards Ireland the points of more frequent action lie near the coast or on it ; that in Great Britain the south coast presents a number of points of activity situated approximatively on a same line, in all probability con-

[1] "Catalogue of Earthquakes having occurred in Great Britain and Ireland during Historical Time ; arranged relatively to Localities and Frequency of Occurrence, to serve as a Basis for an Earthquake Map of the three Kingdoms." With Map. By Jos. P. O'Reilly, C.E., Professor of Mining and Mineralogy, Royal College of Science, Dublin. (*Trans. Roy. I. Acad.*, vol. xxviii. ; *Science*, part xvii., September, 1884.)

nected with a system of jointing corresponding to the general direction of the coast; that therefore the observed connection between volcanoes and coast-lines would hold good to a certain extent as regards these and earthquake action, so intimately related to volcanic action; that, as has been lately remarked by Mr. Wm. White in NATURE (December 25, p. 172), Lancashire is apparently a centre of frequent action, and that there may be a further relation to be found between coal-fields and earthquakes than that recognised up to the present.

It is certainly interesting to note that many of the localities affected by the earthquake of 1884 in the south-east of England lie on or quite near a great circle, which Prof. O'Reilly designates "the west coast of Morocco great circle" (that is a great circle of which the starting-point or part is a portion of that coast lying between Cape Blanco and Cape Juby), traced *à priori*, and which was shown on the Earthquake Map of Europe submitted by him at the Swansea meeting of the British Association in 1881. It will be interesting to note to what extent the complete report on that earthquake, which may soon be looked for, will correspond with his theoretical lines.

As a first attempt to graphically represent the earthquakes of a country relatively to their frequency, Prof. O'Reilly's map has much to recommend it, and, more fully developed and more completely worked out, such maps may yet be considered (to use his own words) as "the necessary *pendants* of geological maps."

JAPANESE LEARNED SOCIETIES

WHEN the Japanese Government decided to participate in the Health Exhibition last year, and to devote special attention to the educational portion of their section, they issued a small pamphlet relating to modern Japanese education. This explained in full the national system organised and put in working order in the last ten years; it dealt with the various classes of schools, from Kindergartens to the University, the technical schools, libraries, and educational museums, the history of ancient Japanese education, &c. The pamphlet showed that the Government of Japan was doing its duty so far as education is concerned; but the reader was left to collect for himself how far the people were following in the wake of their rulers. Since the close of the Exhibition the Japanese Commissioner has re-issued the report, with the addition of a statement of the various learned societies formed for purposes connected with science, literature, and education in that country in recent years. These are purely private associations; some of them are confined to localities removed from the large towns, and bespeak a wide and general interest in these subjects amongst the mass of the people themselves. The work of organising these, when the spirit once existed, cannot have been great, for the Japanese have had for ages their associations of men possessing common tastes, or a common love for a particular subject, whether literature, education, fencing, chess, the study of medicine or of Chinese. These organisations are quite familiar to them, and the work of running the new metal into the old moulds was doubtless not a very difficult one. Accordingly, Mr. Tegima's list is a full one, and here and there it might be suggested that two, or even three, of the separate societies could amalgamate with benefit. Amongst these noted we find the educational society of Japan, which has for its object the study, improvement, and advancement of education; various local societies also intended for the improvement of educational methods in their respective districts; the Seismological Society, perhaps the best known of all in Europe. There are two branches of this, the foreign and the native, the former being the parent society. The "Society of Specialities," which has in view the study "of various special branches of science." The Physical Society, devoted exclusively to the study of the higher physics; there appears to be a second Society of Physics, "composed of professional scholars for the purpose of inquiring into the principles [of physics?] and of interchanging knowledge among the members"; the Mathematical Society for the study of the higher mathematics, and also to translate and compile works on that subject. Among the associations for more general objects we find one of French scholars, foreign and native, for the study of that language, and the general interchange of knowledge, one for the study of the moral sciences, another devoted to European and Asiatic philosophy. The French scholars are not allowed to have it all their own way, for a rival devotes its energies to the study of the German language and laws; Hindoo philosophy also has its own special votaries who have formed themselves into an association for the investigation of this misty subject. The Biological Society of the University of Tokio (founded by Prof. Morse) is among the most energetic of young Japanese societies; the Association for the Translation of the Technical Terms of Physics is a most necessary one, and has a difficult and responsible duty under the present system of translating to fulfil. Sooner or later Japanese and Chinese students will have to adopt most of the technical terms of all departments of science employed in the West; the present plan of seeking to translate them in a rough and fanciful way, and thus forcing the student to learn a new language before he can learn a science, is too clumsy and unsatisfactory to last. Why, for example, oxygen should not be called oxygen by the Japanese student, instead of by some Japanese compound term which is not in the least more explanatory to him, is not quite clear. Meantime a society which will exercise a supervision over the translation of technical terms, and thereby secure uniformity, cannot fail to be useful. The Chemical Society, besides devotion to the science of chemistry, has also for one of its objects the establishment of a regular terminology. The Engineering, Law, Agricultural, Fine Arts, Medical, and Pharmaceutical societies speak for themselves. A second medical society seeks to secure the propagation of sound notions of elementary medicine amongst the common people; in this it is assisted by the members of the Society of Hygiene, who diffuse a general knowledge of sanitary matters. It is pleasant to see that old Japan is not forgotten in this crowd of young associations. The members of a Society of Letters study all branches of Chinese and Japanese literature, while the "Society of Japanese Literature" devotes itself wholly to the study of the etymology and syntax of the Japanese language and to the more general employment of the ancient syllabaries, in place of Chinese characters, in writing. A third literary society has for its object "the interpretation of the moral principles. It aims also to encourage good customs, to promote literature, to educate youth, to diffuse knowledge, and to cultivate moral nature"—a tolerably comprehensive programme. Finally, the recent Fisheries Exhibition has given rise to a Japanese Marine Product Society.

Mr. Tegima's statement is an incomplete one. It deals mainly with associations existing in the capital, and makes little reference to any in other large towns in the Empire, such as Osaka, Nagoya, Niigata, Nagasaki, &c. And even as a list of the Tokio societies it is incomplete. No mention, for example, is made of the most numerous, wealthy, and influential of all—the Geographical Society of Japan; nor is the Dendrological Association mentioned; nor is reference made to the new and interesting society called the *Roma-ji-Kwai*, which has for its object the substitution of Roman letters in Japan for the Chinese characters and the native syllabaries. This Spelling Reform Association has set before itself a huge and radical reform, in comparison with which that of our own Spelling Reform Society is trifling and superficial. Its objects, however, appear hardly practicable, if one may venture to use that expression, of any reform in Japan. But enough has been said to show that the seed sown with such care by the Government is producing a rich harvest among the people of Japan.

THE PROPOSED TEACHING UNIVERSITY FOR LONDON

A LARGELY-ATTENDED and influential meeting of the Association for Promoting a Teaching University for London was held last Thursday at the rooms of the Society of Arts, John Street, Adelphi, under the chairmanship of Lord Reay, the President of the Association, whose objects are—(1) the organisation of University teaching in and for London in the form of a Teaching University, with faculties of arts, sciences, medicine, and laws; (2) the association of University examination with University teaching, and direction of both by the same authorities; (3) the conferring of a substantive voice in the government of the University upon those engaged in the work of University teaching and examination; (4) existing institutions in London of University rank not to be abolished or ignored, but to be taken as the bases or component parts of the University, and either partially or completely incorporated, with the minimum of internal change; (5) an alliance to be established between the University and the professional corporations, the Council of Legal Education as representing the

Inns of Court, and the Royal Colleges of Physicians and of Surgeons of London.

The Chairman said since they last met several things had happened, the most important of which was the appointment by the University of London of a Committee to inquire into the possibility of adopting the scheme, or something like the scheme, which was in the hands of members of that association when they formerly assembled together. The sub-committee of the association had carefully considered since how this move in the Convocation of the University of London affected their prospects and actions, and they had arrived at the conclusion that the best course for them to pursue was to ask the association to allow their scheme to be referred to a committee appointed at that meeting, in which committee all the various bodies who had hitherto shown their sympathy for the sub-committee's scheme should be represented, and to which committee any other proposals could be made by members of the association who in any way disagreed with any of the details of the scheme that had been laid before them. The committee to be appointed would no doubt undertake, as soon as they had finally determined upon a scheme—after negotiation and as a result of negotiation—to present it to the general body of members of the association for their consideration. He thought this was a practical way of dealing with a very intricate and complicated problem. That problem since they last met certainly looked much more hopeful, and it had met with much more rapid support in various quarters than the promoters of the movement originally anticipated

Prof. Williamson said the work before them was one of exceeding difficulty, involving as it did a change in many respects in the conduct of the London University and the placing it upon he footing of other Universities; and this, again, involved a great number of details. The elements of the University of London were so numerous, and many of them were so independently developed in a great degree, that if those various constituent parts—the natural limbs of the University—were to work together it was essential that all should understand what relations they were to hold to each other. The maturing of schemes determining the particular relations of the general University to those various bodies it was sought to connect with it must of necessity require careful, calm, and friendly consideration on the part of representative members. and the committee to be appointed would probably form several sub-committees representing different branches of learning, who might be able to agree upon a general outline of a plan which they would conceive to be most mutually desirable and advantageous. Thus the incorporation of the various limbs of the University, so to speak, might be based upon a distinct understanding of what was contemplated, and they might be induced—as he had no doubt they would be—to vigorously support a scheme which would tend to their mutual benefit and the raising of the standard of education in London.

The resolution was then unanimously adopted.

Lord Justice Bowen moved, and Mr. Erichsen seconded, that the committee consist of the following thirteen gentlemen:—The president of the Asociation, Mr. J. W. Cunningham (King's College), Prof. Carey Foster (University College), Mr. John Marshall (College of Surgeons). Dr. Norman Moore (St. Bartholomew's Hospital), Dr. W. M. Ord (St. Thomas's Hospital), Mr. F. Pollock (Lincoln's-inn), Mr. R. Stuart Poole (British Museum), Dr. P. W. Pye-Smith (Guy's Hospital), the Rev. Principal Wace (King's College), Prof. Warr (King's College), Prof. Williamson (University College), and Sir George Young, with power to add to their number.

Prof. Bentley expressed a hope that the claims of science to be represented on the committee would not be ignored. Further, he trusted that every effort would be made to ascertain all the information which could possibly be derived with regard to the working of medical degrees and the teaching connected with them.

Sir George Young pointed out that the scheme which the committee would prepare was not intended to be binding upon the members; but it was hoped in the end that a plan might be devised which would not only be acceptable to King's College, but other institutions of inferior rank.

Mr. F. Pollock thought the plan of having two Universities, one of which would be an examining and the other a teaching University, would be very difficult to work, and it was not a scheme which he should contemplate as desirable. His feeling was in favour of the closest possible alliance between the examining University of the present and the teaching University of the future.

The Chairman expressed with how much regret he left that scene of action. He was sure that a very great work remained to be done in the future, and that that work would have to be done with a great deal of tact. Certainly it would have to be achieved by setting aside any notion of establishing in London any kind of ideal University. They had to co-operate with existing corporations, with existing bodies, which had hitherto done exceedingly good work, which were all manned by an extremely distinguished *personnel*—a *personnel* whose ideal it had been to do University work without having a University, and which *personnel* he hoped in the future would have at their disposal the University to which their labours had fully entitled them. He did not say this because he himself was guiltless of having mentioned what he believed to be an ideal University, for he had been guilty of such an escapade in the address which he delivered at St. Andrew's University. There he distinctly laid down what he thought to be the lines on which a University ought to be reformed; and, of course, what he advocated for the Scotch Universities he should in the main—of course there were features applicable to Scotch which were not applicable to the London University—also advocate for London. But in London the problem before them was to unite all the interests, to create a federation of interests, and to recognise the work which had been already achieved with the desire to make that work for the future more efficient, without in any way encroaching on autonomy where autonomy had hitherto proved sufficient, but where autonomy had not before proved altogether sufficient, then, to supplement it by that bond of union by which institutioos and empires became great. He resigned his position as President of the Association with the wish—nay, the determined expectation—that they would succeed. He had seen how the work had been thus far done, and how determined had been those with whom he had had the honour to associate to carry the movement to a successful issue.

Sir George Young expressed how greatly they were indebted to the President for the services he had rendered in the past. The services of a very good successor had been secured in Lord Rosebery, whom he (Sir G. Young) proposed as the future president of the association, while thanking Lord Reay for his valuable services.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The second election to the Board of the Faculty of Natural Science was held on February 6. The five retiring members were re-elected, and to make the number of elected members equal to that of the professorial (*ex officio*) members, four new members were elected. After a ballot the following were chosen:—Mr. W. W. Fisher, Aldrichian Demonstrator of Chemistry; Mr. H. B. Dixon, Trinity; Mr. J. Griffiths, Jesus, and Mr. E. H. Hayes, New College.

The Examiners for the Burdett-Coutts Geological Scholarship give notice that the examination will begin on February 23.

An examination will be held at Merton, beginning on June 23, to elect to one Natural Science Scholarship (80*l.*) at Merton, and one at Corpus Christi College. The examination will be in Chemistry and Physics. Candidates must be under nineteen years of age.

On March 17 an examination will be held at Jesus in Physics, Chemistry, and Biology. Candidates must be natives of Wales or Monmouthshire, or born of Welsh parents, and must be under nineteen years of age.

An examination will be held at New College beginning on May 7, to elect to a Natural Science Exhibition (50*l.* value per annum). The examination will be in Chemistry and Piology.

AT a meeting of the Ashmolean Society in the Theatre of the University Museum on Monday, February 16, Prof. Burdon-Sanderson will read a paper "On the Study of Contagion with a view to Practical Measures."

SCIENTIFIC SERIALS

THE last number (13) of the *Journal of the Straits Branch of the Royal Asiatic Society* contains much information on the Malay Archipelago. Mr. de la Croix continues his translation of M.

de Quatrefages's work on the pigmies, the present instalment dealing with the Asiatic pigmies or negritos, and the negrillos or African pigmies. The general conclusion to which the writer comes is that modern science has erred in rejecting all that has been written on this subject by the ancients, for in the midst of many exaggerations and fables there were many facts. He finds it impossible, in the present state of our knowledge, to offer a satisfactory solution of one of the most curious points connected with the geographical distribution of the human race, viz. the narrow resemblance between the Asiatic negritos and the African negrillos, separated as they are by a vast space and by numerous and different races. Are these affinities the result of a common origin? A paper containing a translation of a Dutch account of Malacca, written in 1726, follows this, and is itself succeeded by a long one by Mr. Maxwell, of the Straits Settlement Civil Service, on the laws and customs of the Malays with reference to the tenure of land. The Rev. J. Tenison-Woods prints two lectures on the stream-tin deposits of the protected State of Perak in the Malay peninsula, and the volume concludes with two accounts of travel, one through the State of Remban in the peninsula, the other along the Tawaran and Putalan rivers, which are said to rise in the great mountain Kina Balu, and flow through North Borneo. We observe, also, the prospectus of a very necessary work—an English-Malay dictionary, which, it is suggested, should be translated from Mr. Klinkert's Dutch-Malay dictionary.

Journal de Physique, vol. iv. January.—J. R. Benoit, construction of standard prototypes of the legal ohm. M. Benoit, who was associated with MM. Mascart and de Nerville in the official French researches at the Collège de France, has, at the request of the Minister of Posts and Telegraphs, prepared standards in mercury to represent the legal ohm. This paper gives an account of the methods of calibrating and preparing the tubes for four exact standards. It remains to be seen whether these will prove as permanent as standards constructed in platinum-silver or iridio-platinum alloy.—H. Pellat, on the cause of electrification of storm clouds. Discusses the observations of atmospheric potential at different levels, and concludes that the negative charge of the soil surface is explicable on the hypothesis that it is continually renewed by the falling of negatively charged rain.—E. Bouty, on latent heats of vaporisation. Deduces the approximate law that the latent molecular heats of bodies measured at their normal boiling temperatures are proportional to the squares of these temperatures; tabular evidence is given in support.—E. Bouty, on the specific heat of saturated vapours. Gives a new formula.—Em. Paquet, determination of the ratio of the two specific heats of gases. Describes a modification of Cazin's method, in which the desired change of pressure is brought about by a column of mercury, as in Geissler's mercurial pumps. The deduced value for air is 1·4038.—J. Macé de Lépinay, method of measuring the interior diameter of a barometric tube. Ingenious application of optical laws to deduce internal diameter from the apparent diameter, assuming the refractive index of glass.—G. Quincke, on the measurement of magnetic forces by means of hydrostatic pressure. Abstract of paper in *Philosophical Magazine*, 1884.—W. von Beetz, on normal elements for electromotive measurements. Abstract from *Philosophical Magazine*.—K. Angstrom, a new geothermometer. An underground mercury thermometer is read by means of an index attached to a rack and pinion, which is operated from above. When contact is made with the mercury an electric bell rings, and the index is read off.

SOCIETIES AND ACADEMIES

London

Royal Society, February 5.—"The Relation of Bacteria to Asiatic Cholera." By E. Klein, M.D., F.R.S., Joint Lecturer on General Anatomy and Physiology at the Medical School of St. Bartholomew's Hospital, London.

I propose to bring before the Royal Society the results of an inquiry into the etiology of Asiatic cholera, undertaken, at the instance and expense of the Secretary of State for India, by myself, Dr. Gibbes, and Mr. Alfred Lingard while in India. This investigation will be published *in extenso* by the India Office, but permission has been granted to us to bring to the notice of the Society some of the more important points of our inquiry, particularly those regarding the relation of bacteria to Asiatic cholera. I shall supplement them by giving the results of further observations which I have made since my return from India.

As is now well known, Dr. Robert Koch, in an extensive inquiry into the etiology of cholera in Egypt, Calcutta, and in France, 1883-84, undertaken by him, Drs. Gaffky and Fisher, at the instance of the German Government, has arrived at certain conclusions, which, briefly stated, are these:

1. In all persons suffering from Asiatic cholera there occur in the rice-water stools during the acute stage of the disease certain well-characterised bacteria, which, on account of their curved shape, Koch called "comma bacilli."

2. These comma bacilli are mobile rods, of small size, of about the same thickness as tubercle bacilli, but only of half their length; they are always more or less curved, sometimes as much as to form half a circle; they vary in length according to the state of growth; they occur either singly or in couples, in the latter case arranged like an S.

3. The comma bacilli occur in great numbers in mucus flakes as well as in the fluid of the choleraic evacuations. They occur in the lower part of the ileum of persons dead in the acute stage almost to the exclusion of other bacteria, and in such great numbers that the lower part of the ileum may be considered to contain almost "a pure cultivation of comma bacilli."

4. The mucous membrane of the ileum, particularly that of the lower part, around and in the lymphatic glands located here—the solitary and Peyer's lymph-glands—exhibits in typical and rapidly fatal cases characteristic alterations: loosening and detachment of the epithelium of the surface and of that lining the glands of Lieberkühn; swelling and congestion of the blood-vessels of the mucous membrane, particularly at the peripheral portions of the lymph glands. These alterations are due to the presence, growth, and multiplication of the comma bacilli in these tissues, and the disease cholera is caused by the production on the part of these comma bacilli, and by the absorption on the part of the system of a special chemical ferment.

This state of the presence of the comma bacilli in the tissue is best pronounced in the lower part of ileum; higher up it is more limited, and gradually diminishes, and finally disappears in the upper part of the small intestine.

5. The blood and other tissues are free of any organisms.

6. The comma bacilli grow well outside the body at the ordinary temperature of the room, but better still at higher temperatures up to 38° or 40° C. They divide transversely; after division the two offsprings may remain joined end to end with shape of an S, and by further division they may grow into a spiral-like or wavy form. They grow well in the mucus flakes taken from the intestine, and placed on linen kept in a moist cell; they grow well on potato, in broth, in Agar-Agar jelly, in solid nourishing gelatine mixtures (gelatine, peptone, and beef extract). In this latter substance they exhibit a peculiar and definite mode of growth not seen by Koch on any other bacteria. The comma bacilli require for their growth an alkaline medium; they are killed by acid, by drying, and various antiseptic media.

7. On account of their constant occurrence in the intestines of patients suffering from Asiatic cholera, on account of their absence in all other diseases of the intestine, and on account of their peculiar mode of growth in nourishing gelatine, Koch vindicates for these comma bacilli not only an important diagnostic value, but also considers them as the true cause of cholera.

8. Since his return to Germany, Koch has convinced himself of the correctness of the observations of Nicati and Rietsch, who maintain that cholera can be produced in dogs and guinea-pigs by injecting directly into the small intestine of these animals the comma bacilli taken either directly from the choleraic evacuations, or from artificial cultivations.

Our investigations enable us to say this:

1. Koch's statement as to the constant occurrence of comma bacilli in the rice-water stools of cholera patients is correct; the comma bacilli vary greatly in numbers in different stools and in different cases, in some being exceeding scarce, in others numerous.

2. These comma bacilli vary greatly in length, some being twice and three times as long as others, some well curved as much as to form half a circle, others showing only just a slight bend. The name "comma bacillus" is inappropriate, as in reality they are vibrios.

3. The comma bacilli occur in the mucus flakes of the rice water stools as well as in those taken from the ileum of a person

dead of cholera. The sooner after death the examination is made, the fewer comma bacilli are found in the mucus flakes; even in typical rapidly fatal cases the mucus flakes taken from ileum and examined soon after death (from between fourteen minutes and an hour or an hour and a half) contain the comma bacilli only very sparingly indeed, and not to the exclusion of other bacteria. Our investigations do not bear out Koch's statement as to the lower part of the ileum being in acute typical cases of cholera almost "a pure cultivation of comma bacilli." In not one of the many post-mortem examinations of typical acute cases have we found such a state.

4. The mucous membrane of the ileum of typical rapidly fatal cases, if examined soon after death, does not contain in any part any trace of a comma bacillus or any other bacteria, not even in the superficial loosened epithelium.

If the post-mortem examination is sufficiently delayed, comma bacilla and other bacteria may be found penetrating into the spaces of the mucous membrane.

The theory of Koch's as to the comma bacilli present in the mucous membrane secreting a chemical poison inducing the disease cannot, therefore, be correct.

5. Neither the blood nor any other tissue contains comma bacilli or any other micro-organisms of known character.

6. The behaviour of the comma bacilli in artificial media is not such as to justify their being considered as specific. They grow well in alkaline and neutral media, are not killed by acids, and their mode of growth in gelatine mixtures is not more peculiar than that of other putrefactive bacteria; they show marked differences when grown in different media, but not more so than the ordinary putrefactive bacteria when compared in their growth with one another.

7. Koch overlooked that "comma bacilli" occur in other intestinal diseases, in the mouths of healthy persons, and, as shown recently, even in some common articles of food.

8. The experiments performed by Koch and others on animals do not in the least prove that the comma bacilli are capable of producing cholera or any other disease. The results obtained by them are much easier explained in a manner opposed to that given by Koch and others.

9. There is direct evidence to show that the water contaminated with choleraic evacuations, and containing, of course, the comma bacilli, when used for domestic purposes, including drinking, by a large number of persons, did not produce cholera.

10. The mucus flakes taken from the small intestine of a typical rapidly fatal case of cholera contain numerous mucus corpuscles filled with peculiar minute straight bacilli; in this state they are found when the examination is made very soon after death; soon, however, the mucus corpuscles swell up and disintegrate, and then their bacilli become free.

The small bacilli are never missed in the mucus flakes. They are only one-third or one-fourth the length of the comma bacilli, and about half their thickness. They are non-mobile; they grow well in Agar-Agar jelly, but show in their modes of growth no peculiarity by which they could be considered as specific. When grown on the free surface of the nourishing material they form spores.

11. These small bacilli are not present in the blood, in the mucous membrane of the intestine, or in any other tissue.

12. Experiments made with these small bacilli on animals produced no result.

13. Since my return to London I have ascertained that the comma bacilli of cholera show two distinct modes of division, one the known one of transverse division, and a second one of division in length. When growing in Agar-Agar jelly at the ordinary temperature of the room, after some days the bacilli swell up owing to the appearance in their protoplasm of one or more vacuoles; as these vacuoles increase, so the comma bacilli become gradually changed first into plano-convex, then into oblong bi-convex, and ultimately into circular corpuscles. The longer the original comma bacillus, the larger the final circle. These circular organisms are mobile just as the comma bacilli, and by disintegration of the protoplasm at two opposite points two perfect more or less semicircular comma bacilli are formed. Growing the comma bacilli in Agar-Agar jelly kept at higher temperatures (30-40° C.), the comma bacilli multiply by transverse division only, but transferring these to Agar-Agar jelly and keeping this at the ordinary temperature of the room, they again gradually change into circular organisms, which, by division in the diameter of the circle, form two new comma bacilli.

Linnean Society, February 5.—Mr. Frank Crisp, LL.B., Vice-President and Treasurer, in the chair.—Mr. John Hodgkin was elected a Fellow of the Society.—A paper was read "On the Arbaciadæ, Gray. Part 1, the Morphology of the Test in the genera *Cœlopleurus* and *Arbacia*," by Prof. P. Martin Duncan and W. Percy Sladen. The species of recent and fossil *Cœlopleurus* and the recent forms of *Arbacia* examined present some structural details of both primary and secondary classificatory importance, which have hitherto been neglected and not recorded. The ambulacral plates differ from those of all other Echinoidea in the arrangement of the triplets, there being a central primary plate with an adoral and an aboral demi-plate. It is shown that there are no additional plates near the peristome in the species of *Arbacia*. The structure of the sutures, especially of the median inter-radials, is a modification of the dowelling which has been described in *Temnopleurus* by one of the authors. The double-optic pore noticed by Lovén occurs in the fossil species of *Cœlopleurus*, and in *C. Maillardi*, a recent species. The authors compare the different forms, and exclude *Arbacia nigra* from the genus *Arbacia*. The next part will deal with the classification.—Then followed a paper on Burmese Desmids, by Mr. W. Joshua. The specimens were forwarded by Dr. Romanis, F.L.S., of Rangoon, and got chiefly from the leaves of *Pistia stratiotes* in a tank some twenty-six miles from the mouth of the River Irrawaddy. Of 186 species in sixteen genera hitherto observed, 100 have their representatives in Europe. Altogether some forty supposed new species are described by the author, besides several new varieties and a list of others previously recorded is given.—Mr. W. F. Kirby read a paper on the employment of the names proposed for genera of Orthoptera previously to 1840. In this communication the author shows the application of every name proposed from the time of Linné to the publication of Serville's "Histoire naturelle des Insectes Orthoptères," and there is appended a full bibliography of the subject.

Zoological Society, February 3.—Prof. W. H. Flower, LL.D., F.R.S., President, in the chair.—The Secretary exhibited a specimen of a rare South American Lizard (*Heterodactylus imbricatus*), presented to the Society by Mr. G. Lennon Hunt; and a specimen of a rare Beetle, of the family Buprestidæ, from Beloochistan (*Julodis finchi*).—A letter was read from Dr. George Bennett, F.Z.S., of Sydney, containing remarks on the Tree-Kangaroo of Queensland (*Dendrolagus lumholtzi*), lately described in the Society's *Proceedings*.—A series of specimens of Lepidopterous insects, which had been bred in the insect-house in the Society's Gardens during the past season, was laid on the table.—A communication was read from M. Taczanowski and Count Berlepsch, containing an account of the third collection of birds obtained by M. Stolzmann in Ecuador. The collection contained examples of 289 species, of which ten were new to science.—Lieut.-Col. C. Swinhoe read the first of a series of papers on the Lepidoptera of Bombay and the Deccan. The present communication contained an account of the Rhopalocera, and gave the results of two years' daily collecting.—A communication was read from Mr. Robt. Collett, C.M.Z.S., giving an account of *Echidna acanthion*, a new species of Spiny Ant-eater lately discovered in Northern Queensland.—A communication was read from Mr. Jean Stolzmann, containing the description of a new Rodent, belonging to the genus *Cœlogenys*, from Ecuador, proposed to be called *Cœlogenys taczanowskii*.

PARIS

Academy of Sciences, February 2.—M. Bouley, President, in the chair.—The death of M. Dupuy de Lôme, member of the Section for Geography and Navigation, who died on February 1, was announced by the Secretary.—On the mechanical principles determining the rotation of surfaces on a fixed surface, by M. H. Resal.—Remarks on the cultivation of the phylloxera in tubes, in reply to M. Balbiani's objections to the present practice of destroying the winter eggs of this parasite, by M. P. de Lafitte.—On a plane representation of certain dynamic problems respecting the displacements of a figure of invariable form subjected to four conditions, by M. A. Mannheim.—Description of a selenium actinometer designed for the purpose of measuring the relative intensity of the luminous solar rays at various elevations above the horizon, by M. H. Morize.—On a new preparation of the trifluoride of phosphorus, and on the analysis of this gas, by M. H. Moissan.—Analysis of the green ferrocyanides or glaucoferrocyanides, by MM. A. Étard

and G. Bémont.—On vincetoxine, by M. Ch. Tauret. This term, "vincetoxine" (from Vincetoxicum, the common name of the Asclepias), is applied by the author to a new glucoside, to which is due the remarkable property possessed by the aqueous solution of the hydro-alcoholic extract of the Asclepias root of clouding when the temperature is raised, and becoming limpid when lowered. Vincetoxine has the same centesimal composition as glycyrrhizine, $C_{48}H_{36}O_{18}$.—On the signification of the polarimetric experiments executed with the solution of cotton in the ammonicupric reagent; polarimetric researches on this reagent, by M. A. Béchamp.—On a particular case of catalytic action.—On the composition of the ashes of the Equisetaceæ; its application to the formation of coal, by M. Dieulafait. The author finds that the Equisetaceæ and other typical plants of the Carboniferous epoch contain a much larger proportion of sulphuric acid than those of the present epoch. In this fact we have the natural explanation of the large quantities of sulphur and of sulphate of lime present in all kinds of coal. The sulphur and sulphate entered into the original composition of those plants to whose decomposition are due the carboniferous formations.—On the various cetaceans cast up on the French seaboard during recent years, by M. Georges Pouchet.—Note on the influence of sudden barometric pressure on earthquakes and volcanic activity, by M. F. Laur. Arguing from the fire-damp explosions in mines and other analogous phenomena, the author concludes that all underground disturbances are due to abrupt atmospheric changes communicated even through the medium of the ocean to the crust of the earth. Volcanic eruptions are relatively superficial phenomena due to the expansion of the internal gases when a rupture of equilibrium takes place. Hence they are all the more violent the nearer they are to the surface, and the more closely connected with previously existing terrestrial vacuums.

Berlin

Physical Society, January 23.—Dr. Kayser laid before the Society a photograph of lightning taken in France and probably under the same minimal atmospheric pressure as that under which he had himself taken his recently-published photograph, the lightnings in France having been photographed three days earlier than those in Berlin. On the small gelatinous membrane sent to Dr. Kayser, still better than on that, on an enlargement of the original prepared by the speaker, there was presented very beautifully to view the extraordinarily manifold ramifications of the lightning. From the lowest part of a dark cloud a broad flash of light was seen to dart forth and throw off many fine branches, which again united multifariously, the junction at one place between one branch and another showing a broader line, while at other places the flashes appeared double.—Dr. Lumner spoke on the interference phenomena produced by two plain parallel glass plates. He briefly adduced the experimental results, already published by him, of an investigation of his own, according to which, at small angles of the glass plates, namely, up to as far as 60°, the interference phenomena represented a circle passing, with increasing angles, into an ellipse, the axis of which at 90° were as 1 : 2, until, on still further enlargement of the angle, the ellipse became tran formed into a straight line, which soon in turn, and till the angle of the plates approximated to 180°, changed into a hyperbola. The speaker developed at large the theory of the phenomenon, and deduced the formulæ, which, on inserting the numerical data, were found to coincide remarkably with the experimental results.—A communication from Dr. Müller-Erzbach, designed for the *Verhandlungen*, had been given in and was read. Dr. Müller had sought to determine the sphere of action of the molecular forces by the thickness of the layers arising from the adhesion on solid surfaces of gases and vapours. He chose for his experiments pulverised oxide of iron and carbon disulphide. The latter became, at first very strongly, and then with abating intensity, condensed by the oxide. After four days the quantity of carbon disulphide absorbed in twenty-four hours had sunk to less than 1 mg., without, however, entirely disappearing. By microscopic measurements of the grains of oxide of iron, the author approximately calculated the magnitude of the absorbing surface, and from the quantity of the absorbed carburet of sulphur the thickness of the layer of vapour held fast by adhesion. From the circumstance that the absorption of the vapour very rapidly diminished and after a few days became quite inconsiderable, Dr. Müller-Erzbach concluded that it was not the quantities of vapour at first condensed which drew in those later abso rbed, but that the whole absorbed layer of vapour got to be held fast through adhesion by the surface of the iron, and in this way he arrived at values bearing on the sphere of action of molecular forces which far surpassed all that had been hitherto obtained.—Finally, Prof. Neesen directed attention to the disadvantage of having but one term for two different meanings, such, for example, as the word "Gewicht" (gravity, weight), which was employed to signify both a force and a mass, a confusion which often led to inconveniences. Scientifically either the force or the mass should be called Gewicht, the other being denominated by another name. The debate which this question gave rise to was to be continued at a future sitting.

Vienna

Imperial Academy of Sciences, January 8.—On the fossil flora of Sagor (Carniola), by C. von Ettingshausen.—On pendulum experiments, by P. Czermak and R. Hiecke.—On a new construction of electromagnets for dynamo-machines (sealed packet), by A. von Waltenhofen.

January 15.—On the difference between crystalline and other anisotropic substances, by V. von Ebner.—On a new system of cable-telegraphy for long cable-lines, called the differential recorder (sealed packet), by E. von Taund-Szyll.—On a new method for determining manganese in specular iron ore, ferromanganates, and in the most important ores, by W. Kalmann and A. Smolka.

Stockholm

Society of Natural Sciences, November 15, 1884.—The President, M. Wärn, in the chair.—Prof. Lecke gave an account of a certain fish larvæ which he had studied during a sojourn at Messina. At times the sea was so full of animals, that a vessel immersed in the same would contain as much of the latter as water. He further exhibited a number of rare fish from the Mediterranean, comprising *Trachypterus*, *Peloria*, and *Krohnius*.—Dr. Lindberg explained the working of the Siemens apparatus for registering the quantity and alcoholic contents of spirits. They are now compulsory in all Swedish distilleries, and work very satisfactorily.

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THURSDAY, FEBRUARY 19, 1885

A SCIENTIFIC VIEW OF THE COAL QUESTION

It is well known that our stock of coal is not an infinite quantity, and cannot last an infinite period of time. Different authorities, and those who have investigated the subject, including a Royal Commission, have assigned different lengths of time during which our supply is likely to last; and, according to the most reliable authorities, it cannot be much less than 100 nor much more than 250 years.

Our abundant store of coal, and its application to industrial purposes, has been one of the largest causes of our wealth and progress. The value of coal for those purposes depends essentially upon the fact that it is combustible, and evolves a large amount of heat in burning, and that this heat can be set free at any time and be readily converted into mechanical, chemical, electrical, and other forms of power. As an illustration of the great amount of energy contained in coal, it is well known to scientific men that each piece of it contains sufficient stored-up power to lift its own weight 2300 miles in height, or 2300 times its own weight a mile high. The only other common natural substances to be compared with it in this respect are wood and petroleum, and our stores of these are very small. It is by the expenditure of the energy contained in coal that comparatively valueless iron ore is converted into valuable iron.

It has not been by the mere existence of large quantities of coal in this country, nor entirely by the sale of coal to foreign nations, that so much of our wealth has been obtained, but largely by the circumstance that we were the first nation to apply coal to industrial purposes on a large scale and in a great variety of ways. Other nations also possessing coal, perceiving the great success of this method, followed our example, have overtaken us, and have now rendered it increasingly difficult, year by year, for us to maintain our position as manufacturers.

As also large quantities of coal, petroleum, and inflammable gas are continually being discovered and utilised in other countries, and it is known that the United States of America alone contain nearly forty times as much coal as our entire stock, the time cannot be very far distant when our chances of maintaining even our present position amongst nations by means of our coal will be considerably less than at present. It would be wise, therefore, boldly to face this serious prospect, and consider by what means our national prosperity can be maintained as our coal diminishes in quantity and increases in price, especially as our population is continually increasing, and require to purchase greater supplies of foreign food.

There does exist another and inexhaustible source of wealth and progress, viz. new knowledge obtainable by means of scientific research. It is upon such knowledge, gained by experiments made to examine natural forces and substances, that we must sooner or later depend as a fundamental source of national prosperity. As fast as this knowledge is evolved by discoverers, it is applied in more immediately practical forms by numerous inventors, and then manufacturers and men of business use those practical realities in the production of wealth. This has been the order of events in the past, and will be in the future; this was the way in which we got wealth out of coal. Persons of narrow views on the subject will consider the above proposition vague and unpractical, but this order of things is a great fact and unavoidable; we are the servants of nature, and have no choice in the matter; we might as well hope to live without food as expect to advance in civilisation without the aid of new knowledge.

The practical value of new scientific knowledge as a source of wealth and progress is incomparably greater than that of all the coal-deposits, petroleum springs, and gold-fields of the earth. This great truth, though familiar to scientific investigators, is but little perceived or appreciated by our rulers, or by the mass of their electors; and the chief reason for this is the fact that they possess insufficient knowledge of science. Even Governments can only appreciate that which they understand, and can only act as circumstances and public opinion allow them, and when fettered by an ignorant population, are powerless to preserve a nation from decay.

There cannot be a more complete error than to suppose that new knowledge discovered by means of scientific research is not practical. Its immense practical value has been abundantly proved in a multitude of cases. It was largely by means of such knowledge respecting coal, its properties, constituents, and products, gained by means of experiments, that coal was applied to so many uses. One of the most recent proofs of the practical value of such knowledge is the conversion of the heat of coal into electric current and light in the dynamo-electric machine and electric lamp; the entire existence of these instruments arose from new knowledge discovered in purely scientific researches by Davy and Faraday. It is not necessary to describe here the exact beginnings of gas-lighting, phosphorus-matches, photography, the voltaic-battery, electro-plating, aniline dyes, telegraphy, the telephone, &c.; these, and a multitude of other utilities in common use, had their earliest origin more or less completely, not in the labours of the inventor or of the more directly practical man, but in those of philosophical investigators whose experiments were made with the far more widely practical object, the discovery of new scientific knowledge.

It is not the mere possession of good things, but making the best and earliest use of them that most conduces to success. Our great stock of coal lay comparatively useless as a source of national wealth until philosophical investigators discovered its constituents and properties, and inventors applied these to useful purposes; other nations also possessed coal, and our greater success than theirs was largely and essentially due to the fact that we were the earliest in applying it to important and varied uses. We must not wait, therefore, for those nations to discover for us new knowledge respecting natural forces and substances, but discover it ourselves, in order that we may have the first chance of applying those forces and substances to practical uses, and of offering the useful products for sale or in exchange for food and other commodities.

It is well known that a man who has no faith in medicine will not apply to a physician until death stares him

in the face. Similarly, the average politician and the ordinary elector, having but little knowledge of philosophical experiments, or faith in them, will probably not believe in their great practical value until national distress and panic legislation ensue. The love of money also, and the desire of acquiring it quickly without commensurate sacrifice, fostered by our having so easily obtained it by means of our coal and science, is so strong in this nation, that probably nothing but the actual loss of wealth in the form of diminished value of properties, will induce capitalists and land-owners to perceive and examine the scientific basis of their incomes. When, however, the stern reality of gradually increasing scarcity of coal, and consequent inability to pay for our great supplies of foreign food by means of that coal, and of articles produced by its aid, comes upon us, perhaps the statesmen and wealthy classes of this country will see the indispensable necessity of new scientific knowledge, and be more ready to promote experimental research, with a conviction that its practical results are vast, though not always direct or immediate. G. GORE

MAMMALIAN DESCENT

On Mammalian Descent; the Hunterian Lectures for 1884. By W. Kitchen Parker, F.R.S. (London: Griffin and Co., 1885.)

AS far as we are aware, no attempt has hitherto been made to popularise in any detail the science of comparative embryology. It is therefore indicative of the characteristic originality of Prof. Parker that, on delivering a course of Hunterian lectures upon the embryology of the Mammalia, he should have aimed at charming a popular audience as well as at instructing a scientific one. We confess that upon reading the first paragraphs of his preface, in which he states his intention of handling his subject in a popular way, we felt apprehensive that, like sundry other lecturers with a similar aim and with subjects better suited to the killing of two birds with one stone, he was preparing for himself the misfortune of missing both his marks. But we had not got far into the first lecture without finding that our lecturer very well knew what he was about: he is provided with a double-shotted weapon of the most modern construction, and takes a genuine glee in knocking over some antediluvian tooth-bearing bird on the one side, and the sentimental scruples of a nineteenth-century audience upon the other. And this is done with so much of the vigour of enthusiastic science, as well as the genuine feeling of what we may term unspoiled poetry, that we feel our thanks are due to Miss Arabella Buckley who, it seems, first persuaded Prof. Parker to adopt this delightful method of writing. Moreover, it is obviously to him a natural method. We can everywhere see that he is now writing in the lines of his habitual thinking. The smallest details of his science catch a living glow from the ardour of his imagination, and as this imagination is everywhere charged with biblical thoughts and biblical metaphors, we are led by the force of example to compare it to some quickening spirit which makes all the dry bones of the skulls and skeletons stand up around him as an exceeding great army. Well it is for the cause of evolution that in Prof. Parker it has not only so indefatigable a worker, but likewise so elevated a preacher; and being thus as strong a champion on the side of sentiment as he is on that of science, we have only to congratulate him upon the wisdom of adopting Miss Buckley's advice, and appearing in the lists armed with the weapons of feeling as effectually as with those of fact.

The course consists of nine lectures, and there are, besides, extensive addenda. In the 229 pages to which the book runs, we have presented an excellent epitome of the author's work on the embryology of the Mammalia. The perusal of this epitome cannot fail to strike us anew with admiration at the prodigious amount of his labours, and the great results which they have accomplished. When future generations come to survey the work done by the contemporaries of Charles Darwin in establishing the doctrine of evolution, and in beginning the great task of tracing out the main lines of descent in the animal kingdom, the name of Parker will stand out as one of the most conspicuous of the landmarks.

Two or three quotations from the present volume will serve to convey a general idea of the style, upon which we have laid so much stress. Speaking of a remarkable proboscidian Insectivore, about the size of a rat (*Rhynchocyon cernei*), a ripe embryo of which he has obtained from near Zanzibar, the lecturer says:—

"I have, at present, merely worked out the skull of this valued specimen, but it has rewarded and delighted me more than any kind I have received for a long time past. If nature had titurated together the germs of four or five types of mammals, and had then made this mixture grow, she could scarcely have developed a more curious and composite creature than this long-nosed Insectivore. When Prof. Huxley propounded his oft-quoted theory of the evolution of the Mammalia, he might have known the structure and development of this type by inward sight. Nothing of the kind, however, is ever revealed to biologists in this manner, we only get our facts by opening out the fine folds of organic forms with needle and scissors; we do unroll a good number of the small scrolls, but it is painful and patient work. I am satisfied that no searcher after the evidences of evolution ever saw anything more instructive than what I have found in this small beast. I will make a catalogue of its characters. . . . Thus this greatly specialised kind of Insectivore, whilst retaining the most marked characteristics of the Metatherian skull, takes on two characters, one of which, had it become dominant, would have landed it amongst the Proboscidea, or elephants, whilst the other would have made it a Carnivore. It attempted too much at once, and thus, like a man in doubt, it made but little progress; moreover, in this developmental shilly-shallying, it failed to drop the Marsupial, to take on the new Eutherian, nature, and was thus in danger of going out of being with many of the members of that much-extinguished type. Other types, not thus confused in their ambition, worked out the old strain of Metatherian degradation, and, taking to one definite line of ascent, put on new specialisations in harmony with their surroundings, and to this day their descendants are the rulers of the forest and the field."

Again:—

"Supposing the theory of the slow secular transformation of the old general types into new special types to be true, then the existing mole, in its perfection of adaptive structure, has been as long in coming to its present perfection as the larger and nobler prone or erect types that trample the earth over its head. In its own line, doing its own dark work, it is as complete a creature as the clear-eyed, super-terrestrial types; as a mole, it is con-

summate—a complete and perfect example of a subterranean tyrant; all around him are hosts of juicy grubs and worms, and thereout sucks he no small advantage. Concerning tastes there is no disputing: one naturalist is fond of whales, another of moles, shrews, and mice. All these amusing types must have their supply of food; the great mother, Nature, loves all, and shakes out of her lap plenty for every kind. When we reflect that our country possesses about 1200 species of insects, and that some of the species are prolific beyond all calculation, then we come to understand how the higher insectivorous tribes—birds or small mammals—find so plentiful a table in the wilderness. The hungry, impatient cat, who mistakes a shrew for a mouse, and then leaves her musky prey untasted, would starve upon that which fattens the mole, the shrew, or the bat. The last of these kinds hawks for his small prey, but the shrew, with his delicate proboscis, his sharp eyes, and his quick ears, knows where small beetles most do congregate. These he crunches and munches with exquisite teeth, the cusps or points of which are of a deep ferruginous red colour, more beautiful, strange to say, because they are thus stained. The Power that made the beetle strong in his polished and enamelled armour made also the teeth of the shrew most fit instruments for crushing that armour in which the beetle trusts. It is pleasanter to look upon this vacillation, so to speak, of beneficent purpose from the stand-point of a Darwin than from the stand-point of a Paley; there is much that is painfully mysterious in the whole matter, and we only see it in a partial view."

The lectures concludes thus:—

"When the eyes of the prophet's servant were opened he saw no longer barren rocks with mist resting upon them, but the whole mountain was full of chariots of fire and horses of fire. The vestments and ritual of nature may take up all the attention and use up all the energies of her votaries: these superficial observers fail, however, to find the real religion of nature—the beautiful but awful omnipresence which every flower and every insect reveals. The phenomena of nature are all mere fading pageants, and the really cultivated mind finds lasting satisfaction in meditating upon the recognisable forces that underlie all sensible phenomena.

"This, however, is what the older philosophers called 'dry light,' and is not comfortable to most minds. The deeper things of nature are a sort of manna, but the souls of some people become dried up if you give them merely this celestial kind of diet; so that they murmur and say, 'We remember the fish which we did eat in Egypt, freely; the cucumbers, and the melons, and the leeks, and the onions, and the garlic.'

"And yet this ignorance of nature is set up as a dead wall against all progress of thought; for these people are 'most ignorant of what they're most assured,' certain that they know all about their 'glassy essence'; and, although as blind as moles, they are the enemies of all who have had their eyes opened, to whom the mountain is no longer misty and dark, but flaming with light.

"'Ne sutor supra crepidam'—do not trust the cobbler in things outside his calling—is a proverb that cuts both ways. The biologist may surely be allowed to know things that relate to his own calling: the man who never dreams of life, and the science of life, should be careful how he contradicts its experts. On the other hand, bigotry is not confined to one class of controversialists; some very bitter things have been said by men against faith whose culture and science ought to have taught them better. We have a right to look for nothing but 'sweetness and light' from the apostles and prophets of this new dispensation.

"When the dust of controversy shall have subsided, when those who have to receive new ideas as if by a surgical operation begin to feel the stirrings of these new conceptions thus let into them—the new heaven of nobler thoughts about nature, and of the great First Cause of nature—then all who can think will find that they are colonising a new Atlantis.

"The old song of the creation puts it thus—Evening was—morning was—day one.

"Thus the shadows of the evening came first, and the rosy light of dawn afterwards. Now, in science, even in biological science, the morning is spread upon the mountains, and soaring birds are singing at heaven's gate: so that the drowsiest folk are beginning to stir themselves ere well awake."

We have selected these examples for quotation in order to recommend the book to the class of readers for whom it is primarily intended; but we must not conclude without again observing that the lectures contain so much solid information of the strictly scientific kind, that even the most bigoted of biological experts cannot afford to disregard the material mountain, however little heed they may care to give to the vision of the fiery chariots.

GEORGE J. ROMANES

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Civilisation and Eyesight

In reading Lord Rayleigh's interesting remarks in NATURE (p. 340) upon Mr. Carter's paper, it has occurred to me that we should not, in considering the question of "aperture," entirely omit the fact that this, though probably following a general rule applicable alike to savages and civilised beings, varies in individual cases. An assistant, who has recently left my observatory, had a singularly "sharp" eye, and could pick up with ease companions to double stars, small satellites, &c., which others saw with difficulty. Such were his powers in this respect that I always appealed to him in the case of a doubtful observation. I noticed one day how large the pupils of his eyes were, so large that I asked him if he had taken anything to artificially dilate them. Subsequent examination proved that they were, though of course varying with the stimulus of light, always much larger than those of most other persons, so much so that I laughingly used to call them "cat's eyes." They had also, in fact, a peculiarity, attributed to feline sight, that he could read fine print and distinguish lines by a light much less bright than I could, and habitually used the gas half turned on, &c. Probably such instances would not be rare if they were looked for. Another question arises on this head: Could it be possible that such a condition of the eye, natural in some persons, could, by certain uses of the member, be fostered in others?

I should not have ventured the suggestion but for having read of the "chamois" eye, by which the habitual, or even casual, Alpine hunter can be recognised. I have no references at hand, and it may be it was the look, and not the eye itself, that gave rise to the cognomen; but if there was any change in the eye-conditions, and especially in that of aperture, we might find a reason why the far-gazing savage improves the power of the eye by use. We know that by certain trades—watch-making, for instance—these conditions are varied adversely to long sight, and in the case of sailors and preventive service men a contrary effect seems induced. Lord Rayleigh thinks that the superiority of the savage is only a question of attention and interpretation of minute details, but when one reads that two distant dots are resolved into distinctly-appreciable personages as regards sex, garments, &c., one begins to suspect that "aperture" must also come into play. At all events an inquiry whether these far-seeing savages have large eye-apertures might help the solution of the matter.

The peculiarity affecting my assistant's eyes may be more

common with the savages than with us, or may have been specially prominent in those selected for experiment.

Gildown, February 16 J. RAND CAPRON

Erosion of Glass

SOME time in the end of 1882 Surgeon-Major Biden, writing from Madras, related in NATURE that certain glass vases on which white-ant mud had been deposited had been eroded over the area of deposit in such a way as to suggest that an acid having, like hydrofluoric acid, a power of dissolving glass, was present in the "mud." On reading this I was reminded of the observations of my teacher, Mr. George Rainey, recently deceased.

Mr. Rainey, in the course of his observations on molecular coalescence, had shown that when carbonate of lime was deposited in spherical forms on the surface of a glass slide in the presence of a strong solution of gum, the glass was eroded at every point of contact of a sphere. He explained the phenomenon, as I believe rightly, by the principle of molecular coalescence. In the embrace of the colloid gum, the molecules of the glass adjoining the spheres were drawn into the spheres, and a little cup corresponded to each sphere-contact. There was certainly no question of the action of an acid, the solutions used being distinctly alkaline.

Inspection of the bottles in which the substances have been kept will show that carbonate of lime, moist or dry, carbonate of potash, moist or dry, chloride of calcium, moist or dry, do not in the absence of colloids erode glass. It appeared to me probable that the white-ant mud must consist of a mixture of some colloid with carbonate of lime or some other salt capable of taking spherical form. I wrote to Surgeon-Major Biden stating the possibility as it appeared to me, and suggesting that the mud should be examined as regarded colloid and earthy matter. He replied most courteously that the mud was not at the time to be obtained, but sent some of the earth which formed its basis.

Experimenting with this earth alone, I was not able to etch glass. But in view of some interesting speculations which this episode started for me, I have since made some experiments directly bearing on the possibility of the erosion of glass surfaces by saline matters of alkaline reaction deposited on them within a colloid bed or matrix.

I inclose for your inspection a glass slide which has been so treated. More than a year ago this slide was coated with a layer of paraffin, melted on. The word "Ant" was drawn on the side with a wood point, in the expectation that etching might be effected where the paraffin was removed, the wood point being incapable of scratching the glass. The expectation was not entirely fulfilled. The paraffin, not being sticky enough, scaled off in sheets so as to leave the whole surface ultimately exposed. This whole surface is now seen to be etched. At first sight the glass looks as if it were covered with a semi-opaque deposit. But it has been boiled in hydrochloric acid and in water, without any change becoming evident, and under the microscope the appearance rendered is clearly an appearance of erosion.

The details of the experiment were as follows: a strong solution of gum arabic in distilled water was made and filtered. It was divided into two portions. To one was added a small quantity of chloride of calcium, to the other a small quantity of carbonate of potash. A wide-mouthed bottle, three inches in height, was half filled with the first solution, and the second solution was slowly poured on the top of the first, so as to avoid mixture of the two. The slide, prepared, as already described, was placed vertically in the bottle, so that the middle region of the slide corresponded to the level of the meeting of the two solutions.

The slide was found, at the end of a twelvemonth, denuded of its paraffin, and coated with an incrustation of carbonate of lime most dense at and near the meeting level of the two solutions.

Under the microscope the surface of the slide presents many kinds of erosion—spherical, linear, and intermediate. But in proportion as higher and higher objectives are used, all the appearances are shown to be of circular form, the lines, for instance, being resolved into lines of circular pits.

I dare not make this letter too long, and therefore include in it only so much as bears on Surgeon-Major Biden's most interesting communication. It suffices, at the moment, to indicate that the surface of a glass slide may be eroded in a way to suggest the action of an acid, such as hydrofluoric acid, when no free acid is present; and that erosion may occur when the glass is brought in contact with alkaline fluid, a colloid, and crystalline substances capable of assuming, in the presence of a colloid, spheroidal form.

I propose to state the results of this and other experiments, and some speculations suggested thereby, before the Royal Microscopical Society. WILLIAM M. ORD

7, Brook Street, W.

Echium Crossing

THE gardens of Madeira are remarkable for the neglect of native plants. This is due in part to indigenous indifference, and also to a preference for familiar forms amongst people who migrate hither from various regions, though chiefly to the temptation to test the facilities of growth and naturalisation in a moist and equable sub-tropical climate. Hence it is often easier to import species peculiar to Madeira than to find them in their native place; but none the less do these rocks abound with conspicuous examples of interesting genera.

I have cultivated for many years two large echiums upon the terraces of the Luinta do Valle, 300 feet above the sea, namely, *E. fastuosum*, the Madeiran littoral species, a perennial shrub 3 or 4 feet high, with hairy light green leaves and branching stems crowded with scorpioid racimes of light-blue flowers with white stamens. And secondly, *E. simplex*, the giant Canarian species maturing in Madeira in the second year. This remarkable plant has large, smooth, silvery leaves, and terminates its growth in one unbranched stem densely packed with folded flower-stalks bearing pure white blossoms, and forming a pyramid reaching sometimes 14 feet in height. *E. simplex* dies after flowering. The flowers in both species last from three to five weeks, and the unfolded flower-stalks measure 2 to 3 inches in length.

Until 1882 the two echiums, though growing together and having their scentless flowers freely visited by bees and insects for their abundant nectar, had remained distinct; but, in 1883, after introducing a swarm of Ligurian bees from England, I found that a cross-fertilisation had been effected, which has left me very few examples of *E. simplex*.

The hybrid Echium possesses the leaves of the giant plant, and the stem merely bifurcates or branches sparingly. The flowers are tinged light blue, and the perennial habit of *E. fastuosum* is expressed by a continual growth of the flower racimes, which, after flowering for two years, measure 26 inches in length, and are still unfolding. The seeds of this hybrid have not germinated.

I am now preparing to effect a cross between *E. simplex* and the handsome mountain *E. caudicans* of this island at my country residence, 2000 feet above the sea.

E. caudicans and *E. fastuosum* have frequently blended, producing plants less new in structure than in habit; but such hybrids have been quickly lost, either in sterility or reversion.

Madeira, January 26 MICHAEL GRABHAM

[This is an interesting case of the spontaneous appearance of a hybrid between two very distinct species. The occurrence of such hybrids is frequent in some genera, such as *Verbascum* and *Primula*, and gives systematic botanists much trouble. There is a striking picture of *Echium simplex* at Teneriffe, in the North Gallery at Kew, No. 23.—ED.]

The Iridescent Clouds

THE coloured fringes and bows described by Mr. N. in Prof. C. Piazzi Smyth's communication (p. 316) are clearly of a totally different character from the iridescent clouds that were so widely remarked in December. I take the "fringes and bows in circles" mentioned by him to be simply the same phenomenon of coloured circles that is so often seen around the moon, which goes by the name of a "corona"; and the reason why it is not easily seen around the sun, except by reflection in glass or water, is that the sun is too dazzling to look at directly. There is another phenomenon of coloured clouds which is probably also alluded to by Mr. N., and that is when thin clouds, usually cirrus, show interference colours, often very vividly; the positions of these colours evidently depending on the structure of the clouds, and being quite irregular with reference to the sun. The iridescent clouds recently observed no doubt owe their colour to the same cause, but the kind of cloud was evidently different, and the colours produced were much more striking. The clouds themselves were quite recognisable as

being of a peculiar type, even when too far from the sun to show any colour. The clouds thus coloured are usually of a much striated or rippled structure, and show the colours generally in small spectra; whereas the clouds seen in December were remarkably smooth in texture, and although often striated, the striations were feeble and comparatively few, and in straight lines, while each cloud showed one regular gradation of colour.

Whether the coloured clouds described by your correspondents, with the exception of those mentioned by Mr. N., were all of the same kind, it is difficult to decide; perhaps they may have been so, in spite of the varieties in their appearance. Some observers describe the body of these clouds as having been dark, in particular your correspondents at Darlington and Broseley (Shropshire), pp. 192, 193, whereas all seen here were white or bright. Still, those clouds seen further south were probably of the same kind, only thicker. The difference in shape is most likely not a radical one, as the larger clouds seen here had wavy, not straight, edges, though their general directions were the same as the sides of the more rectangular ones. The nearest approach here to a pallium of these singular clouds was on the morning of December 12, when there occurred, at 8.15 a.m., an extensive pale steel blue film above the region where the sun was, and reaching to an altitude of 25°.

Dr. H. Geelmuyden, observing at Christiania on December 8 (see p. 264), appears to place the peculiar clouds at a lower level than cirro-cumulus, but as seen here they were always the highest clouds.

In conclusion, I think that Prof. A. S. Herschel is mistaken in supposing these clouds have been "only a good instance of a common sight," but although I never noticed them before, I do not dispute the suggestion of Dr. Geelmuyden that they may be seen more frequently than some of us have thought. I have not seen them since December 13. T. W. BACKHOUSE

Sunderland, February 11

Human Hibernation

I DID not answer your correspondent's query on human hibernation in your issue of the 5th inst. (p. 316), because I thought some one better informed than myself would answer it. However, as no one has done so, I may as well give a solution of this well-known Indian trick which I have seen, but the authority for which, I am sorry to say, I cannot remember. It is very simple, like all these things are when you "know how they are done." A tunnel is dug from the grave to the neighbouring jungle; the grave itself is partly prepared. The subject is then, in sight of the spectators, prepared, by having his ears and nostrils filled with wax, and his tongue turned back. He is then apparently buried, creeps through the tunnel, and gets away. After six months, or any other interval, he creeps back again, is dug up apparently lifeless, and restored with infinite pains. In some cases, I believe, a sentry has been placed over the grave, but, of course, without results

ALFRED H. HULK

Bolney House, Ennismore Gardens, S.W., February 13

An Error in Ganot's "Physics"

I BEG to call attention to a typical error in a formula which appears to have run through ten editions of Ganot's well-known treatise. It is one not difficult of discovery by that somewhat too rare class of students who carefully plod through all the steps which lead up to it, but very likely to be overlooked by the more common class who are content to extract the formula as it stands with the undoubting faith reasonably based on "Tenth Edition, revised and enlarged."

The formula which represents the weight of air saturated with vapour occurs on p. 325 of the tenth edition, and is printed—

$$P = \frac{0 \cdot 31 \times V.F}{(1 + \alpha t)\,760}\,(H - \tfrac{3}{8}F).$$

The first F should obviously be expunged.

E. DOUGLAS ARCHIBALD

Tunbridge Wells, February 16

Shadow on Clouds

I AM not aware if the following phenomenon is at all common, but I venture to think it somewhat unusual, and that it might nterest some of your readers:—

Whilst at anchor in Cumberland Bay in the Island of Juan Fernandez on the evening of December 24, 1884, we observed the following remarkable sight. The Bay is situated on the north side of the island, and some way inland is a remarkable hill, called the "Yunkua," or "anvil," it being somewhat of the shape of one; it is the highest hill in the place, viz. 3005 feet, and from the anchorage bears about south-west, and is distant two miles. The Bay is closed in by high cliffs and hills. On the day mentioned, shortly after the sun had disappeared behind the western hills, we observed this hill make a distinct shadow on the clouds above it, in which every irregularity and peak came out with wonderful clearness. The shadow lasted till about 30" before the time of sunset (which was invisible to us), and was inverted and inclined to the hill as in a mirage at about 30°. The weather at the time was very fine. Barometer, 30·22; temperature of altitude thermometer, F. 62°; and very few clouds were about. ALFRED H. TARLETON

H.M.S. *Constance*, at Sea, January 25

THE METEOROLOGY OF HAVANA[1]

THIS annual of the Royal College of the Society of Jesus at Havana for 1875, which has just been published, possesses more than a passing interest. The observations were made daily every two hours from 4 a.m. to 10 p.m., and include pressure, temperature, humidity, wind, rain, magnetic, electric, optical, and other weather phenomena. The results are plotted on large monthly diagrams, and as each day has six-tenths of an inch devoted to it, the two-hourly observations of all the different elements can be readily seen and compared with each other; and this part of the work is done with a scrupulous care and accuracy it would not be easy to surpass. On the same diagrams are marked the days on which auroras are reported to have been observed in the United States, as published in the *Monthly Weather Review* at Washington.

A note is appended to each month's observations, drawing attention to the more significant of the magnetic perturbations in their relations to the changes of weather at the time, and in particular to the "nortes," or "northers," of the cooler months of the year. Thus, on April 3, 4, and 5 a "norther" prevailed, which was succeeded on the three following days by a remarkable magnetic perturbation, which was accompanied with a high barometer and a strong wind, rising in the afternoons to a rate of 35 kilometres per hour, with daily manifestations of aurora in the United States, but was unaccompanied throughout with any electric phenomena. Again, the magnetic perturbation of April 13 was coincident with a characteristic "norther," much thunder and lightning, a very heavy rainfall, and a disposition and state of the aqueous vapour which give rise to solar and lunar halos, and other optical effects; but during the time no auroras were reported from the United States. Father Viñes points out in the monthly notes various other relations between the magnetical and meteorological phenomena which suggest that this line of inquiry is likely to lead to valuable additions to our knowledge of weather changes.

The mean annual pressure at sea-level is 30·067 inches, the maximum being 30·129 inches in January and the minimum 30·002 inches in September, with a secondary maximum of 30·092 inches in July and minimum of 30·066 inches in April. As regards the diurnal oscillation from the morning maximum to the afternoon minimum, the greatest occurs in the winter months, when it amounts to 0·080 inch, whereas in July it is only 0·051 inch. These diurnal and seasonal fluctuations in their varying amounts have no small significance in their relations to the analogous phenomena in the United States and over the high pressure area of the Atlantic. The mean annual temperature is 77°·7, rising to the maximum 82°·2 in July, and falling to the minimum 73°·0 in December. The

[1] "Observaciones Magnéticas y Meteorólogicas del Real Colegio de Belen de la Compañia de Jesus en la Habana. Año de 1875." (Habana, 1884.)

absolutely highest temperature, 98°·8, occurred at 4 p.m. on July 30 under very striking circumstances. For four days previously auroras had been observed in the United States; the magnetic and electrical conditions showed marked disturbances at Havana; atmospheric pressure, which had been low, began to rise on the 30th, on which day, at 2 p.m., the relative humidity fell to 45, but rose four hours after to 84. The temperature, which at 4 p.m. was 98°·8, thereafter instantly and rapidly fell, and by 6 p.m had fallen to 78°·8. The lowest temperature for the year, 55°·9, occurred at 6 a.m. on December 16, at the termination of a "norther," which overspread the sky with cirri, attended with solar and lunar halos; and was immediately followed by a low barometer, remarkable hygrometric changes and irregularities in the direction and velocity of the wind.

Excepting a greater tendency to southing during the warmer months, the wind varies little in direction from month to month. The diurnal variation is interesting. From 10 p.m. to 8 a.m. it is E. by S.; at 10 a.m. E. by N.; from 10 a.m. to 2 p.m. N.N.E.; 4 p.m. N.E.; 6 p.m. E.N.E.; and at 8 p.m. E., thus showing in a marked manner the influence of the sea breeze at Havana. The daily changes in the wind's velocity are very large. The minimum occurs from 4 to 6 a.m., and the maximum from noon to 4 p.m., the maximum velocity being four times greater than the minimum. The strongest winds occur in April, and the weakest in November; the winds in April blowing with double the velocity of those in November. As regards direction, the strongest winds are the sea winds which blow from N.N.E. and E., and the weakest the land-winds from E.S.E., S.E., and S.W., the former blowing with double the force of the latter.

The annual curve of thunderstorms is a very decided one. Of the eighty recorded during 1875, sixty-five occurred during the five months from May to September, and only three during the four months from January to March and December. The annual rainfall was 42·39 inches, about half of the whole amount falling in August and September, during which time 20·61 inches fell. Only a quarter of an inch fell in December, and half an inch in November. The total evaporation for the year was about 60 inches, the maximum, 6·92 inches, being in April, when the air is driest and the winds strongest, and the minimum 3·60 inches in September, October, and November, when the air is most highly saturated and the force of the wind least. As regards the occurrence of rain at different periods of the day, more than 50 per cent. of the whole hours during which rain is noted to have fallen were between noon and 6 p.m., thus closely associating the rainfall with the diurnal period of the thunderstorms. The almost total absence of the thunderstorm from the rains of the winter months, as compared with the summer months, when lightning, or some other electric phenomenon occurs almost daily, is an important feature in the climate of Havana from its bearing on the theory of the thunderstorm.

THE WHALE EXHIBITION IN HAMBURG

DURING the autumn of last year an exhibition of considerable novelty and interest to zoologists was held in Hamburg, embracing complete skeletons, parts, and craniæ of whales, products of the same, and apparatus used for catching these greatest organisms of the world from the earliest times to the present day.

The suggestion for this exhibition came from the writer of these lines, who offered to exhibit three of the greatest fin-whale skeletons in existence. Dr. H. Bolau, director of the Zoological Gardens in Hamburg, succeeded, in spite of many obstacles, in arranging this exhibition and collecting interesting and valuable material, towards which Prof. Pagenstecher, director of the Natural History Museum, also contributed greatly by arranging the exhibits and obtaining several rare specimens acquired by the German Expedition of 1882-83 to South Georgia. In this part were also some splendid water-colour drawings from this island, executed by Herr Mostlaff, which were greatly admired.

The exhibition, which was divided into four parts, viz. one for the whale fauna, one for the hunting-gear, one for the whale products, and one historic-ethnographical, took place partly in the open, partly in a hall.

In the first section, naturally, the Cetaceæ, were most prominent, these monsters being mounted in the Gardens. Of true Balænidæ, the Hamburg Zoological Museum exhibited a cranium of *Balæna mysticetus*, L., a very fine specimen. Otherwise the Balænopteridæ, or fin-whales, were most numerous, there being four different species of this family. The most imposing of them all was the skeleton of the "blue" whale (*Balænoptera sibbaldii*, Gray), the greatest animal on earth. It measured 75 feet in length, and was mounted in its natural position. The specimen seemed to have been full grown, as no division between the epiphyse and the vertebral body could be discovered. As an individual osteological curiosity may be mentioned that the jugal bone consisted of two bones, a smaller and a larger piece, which are closely united by strong ligaments.

Not far from this specimen stood the skeleton of the common fine-whale (*Balænoptera musculus*, Companyo), 63 feet long, which was, as Prof. Flower describes it, "in adolescent state." The greater part of the thoracic and lumbal vertebræ showed distinct separation between the epiphyses and the vertebral body, which was also the case with the limbs. Although the length between these two species is not so very great, there is a marked difference between their structure. The fine-whale is remarkable for its lightness and elegance; in proportion to its great length, some parts of the skeleton seem indeed quite fragile, whereas the blue whale shows throughout in its structure a massiveness bespeaking enormous muscular powers. The difference became even more striking when the fin-whale was compared with a third species, the *Megaptera boops*, O. Fabr. This skeleton was 54 feet long, and therefore a large individual, and was found dead at sea between the coasts of Norway and Russia. From the complete development of the ossification and coalescence of epiphyses with the vertebral bodies and respective diaphyses of the extremities it was clearly a full-grown animal. It gives an impression of heaviness, on account of the short, thick bones and the great length of the fore-limbs, 14-15 feet, which is very apparent. To this individual belongs the whale-bone complex, part of which was shown. Near the same a cranium of this species of whale was exhibited with a complete whale-bone complex. This was a very fine specimen, and was prepared for the Museum of Natural Sciences at Stuttgart, where it now is.

The above-mentioned skeletons and crania were prepared by me in 1883 at the whaling establishments at Vardö (lat. 70½° N.), but the three skeletons, which were, I may be permitted to say, very complete and fine specimens, I had steamed and finished in Hamburg.

In the open, too, there was mounted a skeleton of *Balænoptera rostrata*, Fabr., the smallest of all fin-whales; but this specimen left much to be desired in the way of completeness and finish. It was, however, interesting by its history and age, and is perhaps the oldest Cetacea in any museum. For 200 years it has been instated in the town hall at Bremen, where there is an inscription on the wall to the effect that the animal stranded at Bremerhafen on May 9, 1669, whence it was brought to Bremen, and the skeleton accorded the above-mentioned honour.

As representative of the great "tooth" whales, there was the lower jaw of a spermaceti whale belonging to an

individual which, in 1849, was taken at the Canary Islands.

Dr. Bolau had drawn some very interesting maps showing the habitat of the Greenland whale, the Antarctic whale, the blue, and the spermaceti whales, which were greatly admired.

One of the most valuable exhibits was, however, the cranium of a narwhale (*Monodon monoceros*, L.) with two tusks. It was brought to Hamburg from Greenland in 1684. There are, I believe, at present in Europe only a dozen such craniæ, among which the one exhibited here is certainly the oldest. The most remarkable feature about this cranium is, however, if the inscription attached can be relied on, that it is that of *a female*. The tusk is, as is generally known, never developed in the females. The description is accompanied by a drawing of the whale and a young one, stated to be the offspring of the former. It is, nevertheless, hardly possible to accept this statement, at variance with all experience.

In addition to tusks of narwhals, skeletons and stuffed specimens of other kinds of tooth-whales were exhibited, as, for instance, of *Orca gladiator*, *Delphinus delphis*, *Phocæna communis*, *D. tursio*, and a cranium of bottlenose *Hyperoodon latifrons*, Gray, which, according to the latest researches, is only the male of *H. diodon*.

Of the fœtus exhibited I may mention those of *Balænoptera rostrata*, Fabr., *Rhinodelphis levcoplevrus*, Rasch., and one of *Megaptera boops*, Fabr., only 12 inches long, exhibited by the writer.

Besides the exhibits belonging to the order of Cetaceæ, there were some fine specimens of *Sirenia*, as *Manatus* and *Halicore*, skeletons as well as stuffed animals, exhibited by the University of Kiel. There were, further, a fine collection of seals, of which I shall, however, only mention *Otaria Godeffroy*, from the coast of Peru. As some of the greatest curiosities, should be added, a perfect stuffed specimen of the sea-elephant, 11 feet long, and two sea-leopards from South Georgia.

The exhibition was visited by a considerable number of zoologists, and may, in every respect, be said to have been a success. G. A. GULDBERG

The Zootomical Museum, Christiania

CHESTER NEW MUSEUM

THE foundation-stone of this museum was laid on February 5 by the Duke of Westminster, K.G. We have previously referred to the work done by the Chester Natural Science Society, and the Archæological Society, whose joint museum is now to be placed in a permanent building, uniting under one roof accommodation for it, an art gallery, and every provision for Science and Art Department classes. The remains of ancient Chester, which came to light from time, found their way to the British Museum up to the year 1849, when the Rev. W. H. Massie, the Rector of St. Mary's-on-the-Hill, called a meeting to consider the formation of a museum, and a society was formed for "the illustration and preservation of the remains of antiquity and other objects of interest in the city and in the county." The Society's "collection" was first housed in a cupboard at the Commercial Buildings; thence it was removed, first, to the Episcopal Palace in Abbey Square, afterwards to a house in Lower Bridge Road, to join the Museum of the Natural Science Society, whose collections are of considerable extent and essentially local in character, thanks to the marked love of nature and zeal for scientific research infused into many of the Chester citizens by the founder of the Society, the late Canon Kingsley, and the admirable rules for directing local investigation by which the Society is governed. Under the presidency of Prof. McKenny Hughes, the Society remains as vigorous as ever, as is the Archæological Society under that of Dean Howson, who, since the failing health of Mr. Thomas Hughes, F.S.A., to whom great credit is due, has taken an active interest in the Society, and in 1882 became the chairman of a joint committee to secure a building to answer all the requirements of science and art in Chester. This Committee selected a site in the Grosvenor Road, the greater part of which was at once placed at their disposal by the Duke of Westminster, who, moreover, headed the subscription list with the munificent sum of 4000*l*., to which the Committee have since received promises of sums amounting to a further 3500*l*.

The architect is Mr. Thos. M. Lockwood, of Chester: the tender for the erection of the work accepted by the Committee is for 8150*l*. The elevation of the building, with its octagonal turret, with lantern surmounted by a quaint ogee roof, surmounting a steep-pitched roof, suggests the municipal architecture of Holland. The joint library and reading room is 21 feet by 19; the natura history museum is 36 feet by 25; the lecture theatre 44½ feet by 30; the art and archæological gallery is 60 feet by 23; on the first floor are science class rooms; on the second those for art. Space is reserved for future extensions in all departments.

Prof. McKenny Hughes stated the object of the Museum to be three-fold, being "intended for teaching, for study, and for exhibition. We have long carried on teaching in this old city in connection with the societies which have for their object the study of natural science, but that is to be extended. We have already extended it by putting ourselves in connection with the teaching powers of South Kensington, and now we will bring this into shape and have class-rooms and teachers definitely appointed to carry on the work which has been so nobly taken up by your citizens. The Duke has mentioned already that he felt that a great deal of the work had been done by the enterprise of the citizens. Well, that is the work which we intend to carry on in the teaching departments of this institution; but it is also intended for study. The world is going on fast in the direction of knowledge. Every one is trying to acquire knowledge which shall be turned to money, or which shall be pursued for its own sake, or which will add to the comfort of the community. In all these directions we hope to assist. Men may come in here and study in the library, or in the laboratories, or in the museum."

At the subsequent dinner the chairman, the Dean of Chester, stated that Canon Kingsley gave impulse to the study of natural history in this place, which has by no means lost its momentum. What the Duke of Westminster has said concerning the deep interest taken today in scientific subjects is most strictly in harmony with the facts of the case. There is here, deeply-rooted in the minds of many, a determined love for science of this kind, which is the best possible augury for benefits to result from our museum.

Sir Philip Cunliffe Owen, K.C.M.G., C.B., responding for art, said, "this is a museum after my own heart, for I think it corresponds entirely with what was in the mind of the Prince Consort when he established the Science and Art Department and the South Kensington Museum. It was a part and parcel of his scheme that the teaching and the examples should be under one roof, and it has been found that the example of the Science and Art Department, combined as it is with one of the finest art museums in the world, and combined as it will be, I hope, in the near future with one of the finest science museums that may be created, has done more good, not only in this country, but throughout the world, than anything else which had been thought of before. When we think of the museums of the past, we know that they could not speak for themselves; they were examples, but however interesting and however ancient they might have been, they had no speaking powers, because they were not in combination with a teaching organisation."

CHAS. E. DE RANCE

THE CLASSIFICATION OF THE VARIETIES OF THE HUMAN SPECIES.[1]

THE most ordinary observation is sufficient to demonstrate the fact that certain groups of men are strongly marked from others by definite characters common to all members of the group, and transmitted regularly to their descendants by the laws of inheritance. The Chinaman and the Negro, the native of Patagonia and the Andaman Islander, are as distinct from each other structurally as are many of the so-called species of any natural group of animals. Indeed it may be said with truth that their differences are greater than those which mark the groups called genera by many naturalists of the present day. Nevertheless, the difficulty of parcelling out all the individuals composing the human species into certain definite groups, and of saying of each man that he belongs to one or other of such groups is insuperable. No such classification has ever, or indeed, can ever, be obtained. There is not one of the most characteristic, most extreme forms, like those I have just named, from which transitions cannot be traced by almost imperceptible gradations to any of the other equally characteristic, equally extreme, forms. Indeed, a large proportion of mankind is made up, not of extreme or typical, but of more or less generalised or intermediate, forms, the relative numbers of which are continually increasing, as the long-existing isolation of nations and races breaks down under the ever-extending intercommunication characteristic of the period in which we dwell.

The difficulties of framing a natural classification of man, or one which really represents the relationship of the various minor groups to each other, are well exemplified by a study of the numerous attempts which have been made from the time of Linnæus and Blumenbach onwards. Even in the first step of establishing certain primary groups of equivalent rank there has been no accord. The number of such groups has been most variously estimated by different writers from two up to sixty, or more, although it is important to note that there has always been a tendency to revert to the four primitive types sketched out by Linnæus, the European, Asiatic, African, and American, expanded into five by Blumenbach by the addition of the Malay, and reduced by Cuvier to three by the suppression of the two last. After a perfectly independent study of the subject, extending over many years, I cannot resist the conclusion, so often arrived at by various anthropologists, and so often abandoned for some more complex system, that the primitive man, whatever he may have been, has in the course of ages divaricated into three extreme types, represented by the Caucasian of Europe, the Mongolian of Asia, and the Ethiopian of Africa, and that all existing individuals of the species can be ranged around these types, or somewhere or other between them. Large numbers are doubtless the descendants of direct crosses in varying proportions between well-established extreme forms; for, notwithstanding opposite views formerly held by some authors on this subject, there is now abundant evidence of the wholesale production of new races in this way. Others may be the descendants of the primitive stock, before the strongly marked existing distinctions had taken place, and therefore present, though from a different cause from the last, equally generalised characters. In these cases it can only be by most carefully examining and balancing all characters however minute, and finding out in what direction the preponderance lies, that a place can be assigned to them. It cannot be too often insisted on, that the various groups of Mankind, owing to their probable unity of origin, the great variability of individuals, and the possibility of all degrees of intermixture of races at remote or recent periods of the history of the species, have so much in common that it is extremely difficult to find distinctive characters capable of strict definition, by which they may be differentiated. It is more by the preponderance of certain characters in a large number of members of a group, than by the exclusive or even constant possession of these characters in each of its members, that the group as a whole must be characterised.

Bearing these principles in mind, we may endeavour to formulate, as far as they have as yet been worked out, the distinctive features of the typical members of each of the three great divisions, and then show into what subordinate groups each of them seems to be divided.

To begin with the Ethiopian, Negroid or Melanian, or "black" type. It is characterised by a dark, often nearly black, complexion; black hair, of the kind called "frizzly" or, incorrectly, "woolly," *i.e.* each hair being closely rolled up upon itself, a condition always associated with a more or less flattened or elliptical transverse section; a moderate or scanty development of beard; an almost invariably dolichocephalic skull; small and moderately retreating malar bones (mesopic face[1]); a very broad and flat nose, platyrhine in the skeleton; moderate or low orbits; prominent eyes; thick, everted lips; prognathous jaws; large teeth (macrodont); a narrow pelvis (index in the male 90 to 100); a long fore arm (humero-radial index 80), and certain other proportions of the body and limbs which are being gradually worked out and reduced to numerical expression as material for so doing accumulates.

The most characteristic examples of the second great type, the Mongolian or Xanthous or "yellow," have a yellow or brownish complexion; coarse, straight hair, without any tendency to curl, and nearly round in section, on all other parts of the surface except the scalp, scanty and late in appearing; a skull of variable form, mostly mesocephalic (though extremes both of dolichocephaly and brachycephaly are found in certain groups of this type): a broad and flat face, with prominent, anteriorly-projecting malar bones (platyopic face); nose small, mesorhine or leptorhine; orbits high and round, with very little development of glabella or supraciliary ridges; eyes sunken, and with the aperture between the lids narrow; in the most typical members of the group with a vertical fold of skin over the inner canthus, and with the outer angle slightly elevated; jaws mesognathous; teeth of moderate size (mesodont); the proportions of the limbs and form of the pelvis have yet to be worked out, the results at present obtained showing great diversity among different individuals of what appear to be well-marked races of the group, but this is perhaps due to the insufficient number of individuals as yet examined with accuracy.

The last type, which, for want of a better name, I still call by that which has the priority, Caucasian, or "white," has usually a light-complexioned skin (although in some, in so far aberrant cases, it is as dark as in the Negroes); hair fair or black, soft, straight, or wavy, in section intermediate between the flattened and cylindrical form; beard fully developed; form of cranium various, mostly mesocephalic; malar bones retreating; face narrow and projecting in the middle line (pro-opic); orbits moderate; nose narrow and prominent (leptorhine); jaws orthognathous; teeth small (microdont); pelvis broad (pelvic index of male 80); forearm short, relatively to humerus) (humero-radial index 74).

In endeavouring further to divide up into minor groups the numerous and variously-modified individuals which cluster around one or other of these great types, a process quite necessary for many practical or descriptive purposes, the distinctions afforded by the study of physical characters are often so slight that it becomes necessary to take other considerations into account, among which geographical distribution and language hold an important place.

I. The Ethiopian or Negroid races may be primarily divided as follows:—

A. African or typical Negroes—inhabitants of all the

[1] From the President's Anniversary Address to the Anthropological Institute of Great Britain and Ireland, Jan. 27, 1885.

[1] Oldfield Thomas, in a paper read before the Anthropological Institute, Jan. 13, 1885.

central portion of the African continent, from the Atlantic on the west to the Indian Ocean on the east, greatly mixed all along their northern frontier with Hamitic and Semitic Melanochroi, a mixture which, taking place in various proportions and under varied conditions, has given rise to many of the numerous races and tribes inhabiting the Soudan.

A branch of the African Negroes are the Bantu—distinguished chiefly, if not entirely, by the structure of their language. Physically indistinguishable from the other negroes where they come in contact in the Equatorial regions of Africa, the Southern Bantu, or Kaffirs, as they are generally called, show a marked modification of type, being lighter in colour, having a larger cranial capacity, less marked prognathism, and smaller teeth. Some of these changes may possibly be due to crossing into the next race.

B. The Hottentots and Bushmen form a very distinct modification of the Negro race. They formerly inhabited a much larger district than at present; but, encroached upon by the Bantu from the north and the Dutch and English from the south, they are now greatly diminished, and indeed threatened with extinction. The Hottentots especially are much mixed with other races, and under the influence of a civilisation which has done little to improve their moral condition, they have lost most of their distinctive peculiarities. When pure-bred they are of moderate stature, have a yellowish-brown complexion, with very frizzly hair, which, being less abundant than that of the ordinary negro, has the appearance of growing in separate tufts. The forehead and chin are narrow, and the cheekbones wide, giving a lozenge shape to the whole face. The nose is very flat, and the lips prominent. In their anatomical peculiarities, and almost everything except size, the Bushmen agree with the Hottentots; they have, however, some special characters, for while they are the most platyrhine of races, the prognathism so characteristic of the negro type is nearly absent. This, however, may be the retention of an infantile character so often found in races of diminutive stature, as it is in all the smaller species of a natural group of animals. The cranium of a Bushman, taken altogether, is one of the best marked of any race, and could not be mistaken for that of any other. Their relation to the Hottentots, however, appears to be that of a stunted and outcast branch, living the lives of the most degraded of savages among the rocky caves and mountains of the land of which the comparatively civilised and pastoral Hottentots inhabited the plains.

Perhaps the Negrillos of Hamy, certain diminutive round-headed people of Central and Western Equatorial Africa, may represent a distinct branch of the Negro race, but their numbers are few, and they are very much mixed with the true Negroes in the districts in which they are found. They form the only exceptions to the general dolichocephaly of the African branch of the Negro race.

C. *Oceanic Negroes* or *Melanesians*.—These include the Papuans of New Guinea and the majority of the inhabitants of the islands of the Western Pacific, and form also a substratum of the population, greatly mixed with other races, of regions extending far beyond the present centre of their area of distribution.

They are represented, in what may be called a hypertypical form, by the extremely dolichocephalic Kai Colos, or mountaineers of the interior of the Fiji Islands, although the coast population of the same group have lost their distinctive characters by crossing. In many parts of New Guinea and the great chain of islands extending eastwards and southwards ending with New Caledonia, they are found in a more or less pure condition, especially in the interior and more inaccessible portions of the islands, almost each of which shows special modifications of the type recognisable in details of structure. Taken altogether their chief physical distinction from the African Negroes lies in the fact that the glabella and supra-orbital ridges are generally well developed in the males, whereas in Africans this region is usually smooth and flat. The nose, also, especially in the northern part of their geographical range, New Guinea, and the neighbouring islands, is narrower (often mosorhine) and prominent. The cranium is generally higher and narrower. It is, however, possible to find African and Melanesian skulls quite alike in essential characters.

The now extinct inhabitants of Tasmania are probably pure, but aberrant, members of the Melanesian group, which have undergone a modification from the original type, not by mixture with other races, but in consequence of long isolation, during which special characters have gradually developed. Lying completely out of the track of all civilisation and commerce, even of the most primitive kind, they were little liable to be subject to the influence of any other race, and there is in fact nothing among their characters which could be accounted for in this way, as they are intensely, even exaggeratedly, Negroid in the form of nose, projection of mouth, and size of teeth, typically so in character of hair, and aberrant chiefly in width of skull in the parietal region. A cross with any of the Polynesian or Malay races sufficiently strong to produce this, would, in all probability, have also left some traces on other parts of their organisation.

On the other hand, in many parts of the Melanesian region there are distinct evidences of large admixture with Negrito, Malay, and Polynesian elements in varying proportions, producing numerous physical modifications. In many of the inhabitants of the great island of New Guinea itself and of those lying around it this mixture can be traced. In the people of Micronesia in the north, and New Zealand in the south, though the Melanesian element is present, it is completely overlaid by the Polynesian, but there are probably few, if any, of the islands of the Pacific in which it does not form some factor in the composite character of the natives.

The inhabitants of the continent of Australia have long been a puzzle to ethnologists. Of Negroid complexion, features, and skeletal characters, yet without the characteristic frizzly hair, their position has been one of great difficulty to determine. They have, in fact, been a stumbling-block in the way of every system proposed. The solution, supported by many considerations too lengthy to enter into here, appears to lie in the supposition that they are not a distinct race at all, that is, not a homogeneous group formed by the gradual modification of one of the primitive stocks, but rather a cross between two already-formed branches of these stocks. According to this view, Australia was originally peopled with frizzly-haired Melanesians, such as those which still do, or did till the recent European invasion, dwell in the smaller islands which surround the north, east, and southern portions of the continent, but that a strong infusion of some other race, probably a low form of Caucasian Melanochroi, such as that which still inhabits the interior of the southern parts of India, has spread throughout the land from the north-west, and produced a modification of the physical characters, especially of the hair. This influence did not extend across Bass's Straits into Tasmania, where, as just said, the Melanesian element remained in its purity. It is more strongly marked in the northern and central parts of Australia than on many portions of the southern and western coasts, where the lowness of type and more curly hair, sometimes closely approaching to frizzly, show a stronger retention of the Melanesian element. If the evidence should prove sufficiently strong to establish this view of the origin of the Australian natives, it will no longer be correct to speak of a primitive Australian, or even Australoid, race or type, or look for traces of the former existence of such a race anywhere out of their own land. Proof of the origin of such a race is, however, very difficult, if not impossible, to obtain, and

I know nothing to exclude the possibility of the Australians being mainly the direct descendants of a very primitive human type, from which the frizzly-haired Negroes may be an offset. This character of hair must be a specialisation, for it seems very unlikely that it was the attribute of the common ancestors of the human race.

D. The fourth branch of the Negroid race consists of the diminutive round-headed people called Negritos, still found in a pure or unmixed state in the Andaman Islands, and forming a substratum of the population, though now greatly mixed with invading races, especially Malays, in the Philippines, and many of the islands of the Indo-Malayan Archipelago, and perhaps of some parts of the southern portion of the mainland of Asia. They also probably contribute to the varied population of the great island of Papua or New Guinea, where they appear to merge into the taller, longer-headed and longer-nosed Melanesians proper. They show, in a very marked manner, some of the most striking anatomical peculiarities of the Negro race, the frizzly hair, the proportions of the limbs, especially the humero-radial index, and the form of the pelvis; but they differ in many cranial and facial characters, both from the African Negroes on the one hand, and the typical Oceanic Negros, or Melanesians, on the other, and form a very distinct and well-characterised group.

II.—The principal groups that can be arranged around the Mongolian type are—

A. The Eskimo, who appear to be a branch of the typical North Asiatic Mongols, who in their wanderings northwards and eastwards across the American continent, isolated almost as perfectly as an island population would be, hemmed in on one side by the eternal Polar ice and on the other by hostile tribes of American Indians, with which they rarely, if ever, mingled, have gradually developed characters most of which are strongly-expressed modifications of those seen in their allies who still remain on the western side of Behring's Straits. Every special characteristic which distinguishes a Japanese from the average of mankind is seen in the Eskimo in an exaggerated degree, so that there can be no doubt about their being derived from the same stock. It has also been shown that these special characteristics gradually increase from west to east, and are seen in their greatest perfection in the inhabitants of Greenland; at all events, in those where no crossing with the Danes has taken place. Such scanty remains as have yet been discovered of the early inhabitants of Europe present no structural affinities to the Eskimo, although it is not unlikely that similar external conditions may have led them to adopt similar modes of life. In fact, the Eskimo are such an intensely specialized race, perhaps the most specialized of any in existence, that it is probable that they are of comparatively late origin, and were not as a race contemporaries with the men whose rude flint tools found in our drifts excite so much interest and speculation as to the makers, who have been sometimes, though with little evidence to justify such an assumption, reputed to be the ancestors of the present inhabitants of the northernmost parts of America.

B. The typical Mongolian races constitute the present population of Northern and Central Asia. They are not very distinctly, but still conveniently for descriptive purposes, divided into two groups, the Northern and the Southern.

a. The former, or Mongolo-Altaic group, are united by the affinities of their language. These people, from the cradle of their race in the great central plateau of Asia, have at various times poured out their hordes upon the lands lying to the west, and have penetrated almost to the heart of Europe. The Finns, the Magyars, and the Turks, are each the descendants of one of these waves of incursion, but they have for so many generations intermingled with the peoples through whom they have passed in their migrations, or have found in the countries in which they have ultimately settled, that their original physical characters have been completely modified. Even the Lapps, that diminutive tribe of nomads inhabiting the most northern parts of Europe, supposed to be of Mongolian descent, show so little of the special attributes of that branch, that it is difficult to assign them a place in it in a classification based upon physical characters. The Japanese are said by their language to be allied rather to the Northern than to the following branch of the Mongolian stock.

b. The Southern Mongolian group, divided from the former chiefly by language and habits of life, includes the greater part of the population of China, Thibet, Burmah, and Siam.

C. The next great division of Mongoloid people is the Malay, subtypical, it is true, but to which an easy transition can be traced from the most characteristic members of the type.

D. The brown Polynesians, Malayo-Polynesians, Mahoris, Sawaioris, or Kanakas, as they have been variously called, seen in their greatest purity in the Samoan, Tongan, and Eastern Polynesian Islands, are still more modified, and possess less of the characteristic Mongolian features; but still it is difficult to place them anywhere else in the system. The large infusion of the Melanesian element throughout the Pacific, must never be forgotten in accounting for the characters of the people now inhabiting the islands, an element in many respects so diametrically opposite to the Mongolian, that it would materially alter the characters, especially of the hair and beard, which has been with many authors a stumbling-block to the affiliation of the Polynesian with the Mongol stock. The mixture is physically a fine one, and in some proportions produces a combination, as seen, for instance, in the Maories of New Zealand, which in all definable characters approaches quite as near, or nearer, to the Caucasian type, than to either of the stocks from which it may be presumably derived. This resemblance has led some writers to infer a real extension of the Caucasian element at some very early period with the Pacific Islands, and to look upon their inhabitants as the product of a mingling of all three great types of men. Though this is a very plausible theory, it rests on little actual proof, as the combination of Mongolo-Malayan and Melanesian characters in different degrees to the local variations certain to arise in communities so isolated from each other and exposed to such varied conditions as the inhabitants of the Pacific Islands, would probably account for all the modifications observed among them.

E. The native population (before the changes wrought by the European conquest) of the great continent of America, excluding the Eskimo, present, considering the vast extent of the country they inhabit and the great differences of climate and other surrounding conditions, a remarkable similarity of essential characters, with much diversity of detail.

The construction of the numerous American languages, of which as many as twelve hundred have been distinguished, is said to point to unity of origin, as, though widely different in many respects, they are all, or nearly all, constructed on the same general grammatical principle—that called *polysynthesis*—which differs from that of the languages of any of the Old World nations. The mental characteristics of all the American tribes have much that is in common: and the very different stages of culture to which they had attained at the time of the conquest, as that of the Incas and Aztecs, and the hunting or fishing tribes of the north and south, which have been quoted as evidence of diversities of race, were not greater than those between different nations of Europe, as Gauls and Germans on the one hand, and Greeks and

Romans on the other, in the time of Julius Cæsar. Yet all these were Aryans, and in treating the Americans as one race it is not intended that they are more closely allied than the different Aryan people of Europe and Asia. The best argument that can be used for the unity of the American race—using the word in a broad sense—is the great difficulty of forming any natural divisions founded upon physical characters. The important character of the hair does not differ throughout the whole continent. It is always straight and lank, long and abundant on the scalp, but sparse elsewhere. The colour of the skin is practically uniform, notwithstanding the enormous differences of climate under which many members of the group exist. In the features and cranium certain special modifications prevail in different districts, but the same forms appear at widely-separated parts of the continent. I have examined skulls from Vancouver's Island, from Peru, and from Patagonia, which were almost undistinguishable from one another.

Naturalists who have admitted but four primary types of the human species, have always found a difficulty with the Americans, hesitating between placing them with the Mongolian or so-called "yellow" races, or elevating them to the rank of a primary group. Cuvier does not seem to have been able to settle this point to his own satisfaction, and leaves it an open question. Although the large majority of Americans have in the special form of the nasal bones, leading to the characteristic high bridge of the nose of the living face, in the well-developed superciliary ridge and retreating forehead, characters which distinguish them from the typical Asiatic Mongol, in so many other respects they resemble them so much that, although admitting the difficulties of the case, I am inclined to include them as aberrant members of the Mongolian type. It is, however, quite open to any one adopting the Negro, Mongolian, and Caucasian as primary divisions, also placing the Americans apart as a fourth.

Now that the high antiquity of man in America, perhaps as high as that he has in Europe, has been discovered, the puzzling problem, from which part of the Old World the people of America have sprung, has lost its significance. It is quite as likely that the people of Asia may have been derived from America as the reverse. However this may be, the population of America had been, before the time of Columbus, practically isolated from the rest of the world, except at the extreme north. Such visits as those of the early Norsemen to the coasts of Greenland, Labrador, and Nova Scotia, or the possible accidental stranding of a canoe containing survivors of a voyage across the Pacific or the Atlantic, can have had no appreciable effect upon the characteristics of the people. It is difficult, therefore, to look upon the anomalous and special characters of the American people as the effects of crossing, as was suggested in the case of the Australians, a consideration which gives more weight to the view of treating them as a distinct primary division.

III. The Caucasian, or white division, according to my view, includes the two groups called by Prof. Huxley Xanthochroi and Melanochroi, which, though differing in colour of eyes and hair, agree so closely in all other anatomical characters, as far, at all events, as has at present been demonstrated, that it seems preferable to consider them as modifications of one great type than as primary divisions of the species.

Whatever their origin, they are now intimately blended, though in different proportions, throughout the whole of the region of the earth they inhabit; and it is to the rapid extension of both branches of this race that the great changes now taking place in the ethnology of the world is mainly due.

A. The Xanthochroi, or blonde type, with fair hair, eyes, and complexion, chiefly inhabit Northern Europe—Scandinavia, Scotland, and North Germany—but, much mixed with the next group, they extend as far as Northern Africa and Affghanistan. Their mixture with Mongoloid people in North Europe has given rise to the Lapps and Finns.

B. Melanochroi, with black hair and eyes, and skin of almost all shades from white to black. They comprise the great majority of the inhabitants of Southern Europe Northern Africa, and South-west Asia, and consist mainly of the Aryan, Semitic, and Hamitic families. The Dravidians of India, and probably the Ainos of Japan, the Maoutze of China, also belong to this race, which may have contributed something to the mixed character of some tribes of Indo-China and the Polynesian Islands, and, as before said, given at least the characters of the hair to the otherwise Negroid inhabitants of Australia. In Southern India, they are probably mixed with a negrito element, and in Africa, where their habitat becomes conterminous with that of the Negroes, numerous cross races have sprung up between them all along the frontier line. The ancient Egyptians were nearly pure Melanochroi, though often showing in their features traces of their frequent intermarriage with their Ethiopian neighbours to the south. The Copts and fellahs of modern Egypt are their little-changed descendants.

In offering this scheme of classification of the human species, I have not thought it necessary to compare it in detail with the numerous systems suggested by previous anthropologists. These will all be found in the general treatises on the subject. As I have remarked before, in its broad outlines it scarcely differs from that proposed by Cuvier nearly sixty years ago, and that the result of the enormous increase of our knowledge during that time having caused such little change, is the best testimony to its being a truthful representation of the facts. Still, however, it can only be looked upon as an approximation. Whatever care be bestowed upon the arrangement of already acquired details, whatever judgment be shown in their due subordination one to another, the acquisition of new knowledge may at any time call for a complete or partial re-arrangement of our system.

W. H. FLOWER

NOTES

WE have to announce the death of Mr. Geoffrey Nevill, who died at Davos Platz on the 10th inst. He was for many years Assistant Superintendent in the Calcutta Museum, and had charge there of two conchological collections, which were entirely arranged and named by him. He did some good work there.

IN a recent issue we gave some account of the Liverpool Corporation free lectures, which were then in the experimental stage. Since then the lectures have been continued every winter, and we should like to call the attention to them of those of our readers who are interested in the promotion of elementary scientific knowledge among the lower classes, and especially those who have, either as town-councillors or magistrates in their respective towns, influence in their own localities. We have before us a programme of the present course, copies of which can be obtained from Mr. P. Cowell, Liverpool Free Public Library. The lectures are given every Monday, Tuesday, Wednesday, and Thursday from January 5 to March 12 inclusive, in the Rotunda Lecture Hall of the Library, which holds more than 1500 people. The entire expense of them is defrayed by the Corporation, and admission is perfectly free. A member of the Corporation invariably occupies the chair at each lecture. Mr. Lant Carpenter lectured there on the night of February 12 upon "Sunspots and their Connection with Weather Changes," to an audience of great extent. It was composed almost exclusively of "the great unwashed," who had come in straight from their work, or, alas, in some cases, from their inforced idleness; the Liverpool dock porters were there in

their hundreds! The audience, though larger than usual, was not exceptionally so. Notwithstanding the somewhat technical and abstruse nature of the subject, involving an explanation of the application of the principles of spectrum analysis to solar physics (in which the oxyhydrogen lantern illustrations were, during half the lecture, a great assistance), this large audience of *unskilled labourers*, men and youths, listened for nearly an hour and a half with the closest attention, strongly resenting the solitary attempt at interruption, and at the close of the lecture were most enthusiastic in their approval. Why cannot the same thing be done in other large towns, and must we wait for London municipal reform to get it done in the metropolis?

IN *La Nature* of February 14, under the title of "The Struggle for Existence," is a curious account of an attack on a dog by a flock of crows. The account of the affray is given by M. Magin, director of St. Albert Glassworks, Anecht, Nord. M. Magin states that in January last, when the ground was covered with snow, his dog (a *Griffon*) was in a field adjoining the workshop, when he was attacked by a flock of crows. About a hundred were in the field, but only about thirty actually joined. Dividing themselves into two parties, one attacked the poor dog before, and another behind. Rising about two metres above ground, they would plunge their beaks invariably into a bleeding wound. When the dog was rescued by the workmen he was in a dilapidated state, his eye torn out, and a deep wound in the neck. The crows remained about the place for some time after the rescue of the dog.

THE Statistical Society proposes to celebrate the jubilee of its foundation on June 22 and 23 next. It is proposed to invite to the celebration distinguished statisticians from foreign countries, several of whom, it is hoped, will be Government representatives.

THE Mersey tunnel was opened on the 13th inst.; it was begun in the end of 1879. It may be stated that the length of the projected railway is two miles and a half, from James Street, Liverpool, to Green Lane, Tranmere; and from shaft to shaft the distance immediately beneath the River Mersey is about one mile. For the two stations in James Street, Liverpool, and Hamilton Square, Birkenhead, the necessary excavations were some time ago completed.

FOR the first time, we believe, in English warfare, balloons are to be utilised in the Soudan Campaign. The transport *Queen* sailed on Monday from the Thames with the Balloon and Telegraph Corps for the Suakin Expeditionary Force. Three balloons are taken out with all the necessary appliances to be used for taking observations of the enemy's positions. All have been made at the School of Engineering. Compressed hydrogen for inflating the balloons is carried in iron cylinders, 12 feet long by 1 foot diameter, but these are only for a reserve supply, and, weighing half a ton each, will be left behind at the base of operations, where, also, a gas factory and pumping station will be put up. Materials for this purpose are on board the ship, including a small gas-holder, and all the necessary chemicals for making more gas are provided. About a hundred lighter cylinders, easily carried by men, form part of the equipment. Each of these, which are 9 feet long, contains 120 feet of hydrogen in a compressed state, and, as they are emptied, they will be taken back to be recharged at the Suakin station. One waggon, containing one ton of stores, will suffice for a balloon ascent. Captive ascents only will be made, in which the balloons will be tethered by rope or wire, both of which are taken. Communication by telephone will be established between the car and the ground, and the chief employment of the balloons will be to take observations of the enemy's movements.

A MEETING, called together with the object of obtaining a more extended support for the Parkes Museum, was held at the Mansion House on Friday, the Lord Mayor (Mr. Alderman Nottage) presiding. The Lord Mayor, in opening the proceedings, said the object of the organisers of the Parkes Museum was to promote the physical welfare and happiness of, he might say, the human race. Capt. Douglas Galton read a statement on behalf of the joint committee of members and council, from which it appeared that the museum was founded at a meeting presided over by Sir William Jenner in July, 1876, in memory of the late Edmund Alexander Parkes, who was the first Professor of Hygiene in this country. The Queen and other members of the Royal Family had subscribed to the funds, and had taken great interest in the Institution. Out of it had arisen the International Medical and Sanitary Exhibition, and the Health Exhibition. The Museum is open free for a part of every day in the week. The lectures have been given for the benefit of the Working Men's Club and Institute Union, the Institution of Builders' Foremen and Clerks of Works, and the Metropolitan Building Societies. The Museum has also been placed at the disposal of teachers of hygiene, and classes have attended from University College, St. Bartholomew's Hospital, Guy's Hospital, the Royal Engineers, and the Young Men's Christian Association. The reading-room, with its valuable library of sanitary literature, has always been a distinguished feature of the Museum, and has recently been enhanced by the addition of 1500 volumes contributed by the Council of the International Health Exhibition. For upwards of eighty years the Museum has been maintained by voluntary contributions. To keep it open to the public it has become necessary that at least 1000*l*. should be raised by the end of the present month. The Duke of Cambridge moved "That the statement which has been read affords conclusive evidence that the Parkes Museum of Hygiene is meeting a great educational want, and is worthy of increased support." There were two chief considerations which presented themselves to his mind—the first was, that the Society must get out of the difficulties it was in; and next, the Museum must be established on a sure footing, so as to enable its advantages to be extended. The premises at present occupied by the Society must be re-engaged, and it would be necessary to widen its utility in coming years. Mr. Ernest Hart said he thought the wealthy and practical City of London could not be proud of its attitude towards this valuable Institution. Nearly all the supporters of the Museum came from the West-end, and were largely from among the professional and medical classes. The importance of the Museum might be gathered from an outside indication—namely, that the idea had been imitated, and the example extended in the United States, in France, in Italy, and Japan. He thought they were entitled to support, not only from the great merchants and bankers of the City, but from the Corporation and the City Companies. The Parkes Museum was a mere skeleton sanitary museum. It was without a laboratory, without lectures, without demonstrators. In other countries the State subsidised their Health Museums, and that it was deserving of the highest recognition from a merely commercial point of view had been conclusively shown by Sir James Paget's statistics as to the pecuniary national loss from preventible disease. A list of subscriptions amounting to 1006*l*. was announced.

THE death is announced of Mr. Hodder M. Westropp, the well-known archæologist, at the age of sixty-four years.

PROF. JOHN MARSHALL on Saturday, in the theatre of the Royal College of Surgeons, delivered the annual Hunterian oration before a distinguished medical audience. The orator considered the mental attitude which "the Founder of Scientific Surgery" would probably assume towards the active work and salient opinions of our times. The revelations of microscopical research and the growth of a new department of anatomy, histology, would have delighted Hunter, and his acquiescence in the truth of a modified cell-theory of the formation of tissues, and in

the doctrine of the protoplasmic origin of animal and vegetable life, could be easily imagined. Not only as a physiologist, but as a pathologist, Hunter was a great vivisector, and it might be taken for granted that he would rank himself with those who now claim the right of man, for beneficial purposes, or even in the pursuit of knowledge, to attempt to discover the processes of animal life by tests and trials on living animals. While averse to unnecessary repeated experiments, his large views of the unity of the "principle of life" and of the community of organisation and of action throughout the whole animal kingdom would lead him to disregard the objections of those who insist on the uselessness of experiments on animals so far as concerns their application to man. Hunter did not spare his own body, but subjected himself to an inoculation experiment of a very grave character, in order to test opinions on a pathological question, and to put to proof the efficacy of certain variations in treatment. Since his time the inquiry as to the functions of the nerves and the nerve centres had made great strides, almost exclusively by means of experiments. Had Hunter lived now he would have been a staunch evolutionist, his belief being that "from the variations produced by culture it would appear that the animal is so susceptible of impression as to vary Nature's actions, and this is even carried into propagation." Hunter expressed the opinion that in time it might perhaps happen the human race should be exterminated by specific poison diseases; but he regarded it as more probable that many poisons were extirpated, and that new ones might arise in their stead every day.

THE National Fish Culture Association are about to establish a Museum of British and Foreign Fishes, and a large number of valuable specimens have already been presented for preservation. The project has met with unmistakable signs of approbation, and is likely to receive the hearty co-operation of the ichthyological world. The latest addition to the collection is an exceedingly fine specimen of a trout weighing 23 lbs.

IN an address at the last meeting of the Society of Meteorology of France, M. Hervé-Mangon described the growth of meteorological science in that country. It is curious, he said, that in the first part of this century, meteorology had fallen into strange discredit with the most distinguished men of science, one of whom called it "the poor science." The Hydrometric Society of Lyons, founded in 1840, was the only one in France occupying itself with atmospheric phenomena; the *Meteorological Annual* was not founded till 1849, and the Society of Meteorology till 1853. In 1855 Leverrier created the system of telegraphic warnings. In 1878 the Society succeeded in getting the Government to reorganise the system of telegraph weather reports, and to create a central meteorological bureau, while numerous observatories had been erected all over the country, and Paris was now in connection with 1500 stations. In 1852 France participated in the International Congress of Meteorology at Brussels, but for twenty-six years after that they took part in no similar reunion. But, owing to M. Hervé-Mangon's exertions, the Congress of 1878 was invited to be held in Paris, and in 1879 France took formal part in the Congress at Rome.

M. HANSEN-BLANGSTED, of Paris, has recently published, under the title of "Un Progrès," an account of the manner in which the metric system of weights and measures is extending over Europe. Confining himself to Germany, Austro-Hungary, and Norway since 1870, he points out that in German geography down to 1869 all the measures were given in the system of the country. In 1865 *Petermann's Mittheilungen* expressed geographical measures of length, height, depth, and superficial area in German or English measures. In 1869 French measures were employed, that is, they were put side by side with the English and German. Since 1875 the metric system is almost exclusively employed, and it is always added where a writer does not use it. Prior to 1870 the metric system was rarely employed in the *Geographische Jahrbuch*, in 1876 it had made much progress, and now it is almost the only one in use. Dr. Daniel's large geography in four volumes, the fifth edition of which was published by Dr. Delisch in 1882, is used everywhere throughout Germany, and is an undoubted authority. Here all the geographical measures are given according to the metric system; the German system is not used even in parenthesis. In Austria we find that Dr. Umlauft uses the metric system exclusively in his "Rundschau für Geographie und Statistik." In "Das eiserne Jahrhundert" also the same is the rule. Dr. Umlauft has lately published a work devoted wholly to the geography of the Austrian empire, which is widely spread and used in schools. He employs in it only the metrical system. In Norway, the geographical works of the former Minister, M. Broch, both in Norwegian and French, have had much effect in propagating the knowledge and employment of the metric system, for he uses the latter side by side with the Norwegian measures. For the first time in the geography of P. Geelmuyden, published at Christiania in 1882, the metric system is exclusively adopted, the Norwegian measures being placed in parentheses. This work forms one of the text-books for primary and advanced instruction in the schools.

M. NIKITINSKY has recently made a series of experiments for determining whether the amount of ash given by burnt tea-leaves really increases with the decrease of the quality of tea, as was asserted a few years ago. Taking different kinds of tea, the price of which was respectively 72, 64, 34, 12·8, and 12·12 Chinese *lans*, he found that they gave respectively the following percentage of ash: 5·16, 5·21, 5·66, 5·91, and 6·32. The difference is thus very small. A cheap green "brick-tea" gave a percentage of 6·87. The Orenburg teas, which are sold under the name of Buray-tea, at the price of 12 and 5 roubles for 16 kilogrammes, and are adulterated with leaves of *Epilobium angustifolium*, gave a far greater quantity of ash, namely, 7·87 and 10·43 per cent., thus affording a means for discovering this kind of adulteration.

THE Report of the Botanical Record Club for 1883 is just published. For those interested in the details of the geographical distribution of British plants, these annual publications form an indispensable supplement to the posthumous edition of H. C. Watson's "Topographical Botany," published in 1883.

PROF. STRICKER'S work, "Studien über die Sprachvorstellungen," has now been translated into French by F. Schwiedland. This French edition, which has been enlarged by some new chapters by the author himself, is published by Félix Alcan at Paris.

OLDENBOURG of Munich has just published "Die Hieracien Mittel-Europas. Monographische Bearbeitung der Piloselloiden mit besonderer Berücksichtigung der mitteleuropäischen Sippen,' by C. von Nägeli and A. Peter.

AN officer of the French Staff has gone to Algiers and Tunis in order to continue the work of the late Col. Roudaire. But it is not likely that he will succeed, although he is strongly supported by M. de Lesseps. In the colony the opinion is strongly against the scheme. The argument of its opponents is the insalubrity which would result from the presence of these salt waters in an extremely hot country without any appreciable current, and frequent changes of level owing to evaporation.

WE understand that the *Quarterly Journal of Microscopy and Natural Science* will in future be published by Messrs. Baillière, Tindall, and Cox.

MR. A. S. OLIFF and Mr. J. D. Ogilby have been appointed assistants in the Australian Museum.

SHOCKS of earthquake continue to be felt in the south of Spain. A telegram from Granada on the 12th stated that slight shocks continued to be felt at Alhama, and on that day there was a shock at Terre del Campo near Jaen. There were also shocks in the evening of the 14th at Granada and Velez Malaga.

Die Natur takes advantage of the attention at present directed to South Africa, to recall the story of the first astronomical expedition to the Cape. The first expedition ever sent across the seas for such a purpose as astronomical observation was that of Jean Richer, which went to Cayenne on behalf of the Paris Academy, in order that simultaneous observations of Mars should be made there and in Paris. The Cape expedition took place thirty years later. Baron Krosigk, its promoter, had founded a private observatory at Berlin, where observations of the moon's culminations were made for a long period, and observers were sent to the Cape to make corresponding observations there. It was hoped that by collating the observations in both places the moon's parallax would be obtained. So far as this was concerned, the expedition failed. Wagner, the founder and first head of the public observatory at Berlin, carried out his part of the work in Prussia, but Kolb, who had charge of the Cape expedition, was guilty of great negligence, so that the results were inconsistent and unsatisfactory. In 1719 he published a book entitled "Caput bonæ spei hodiernum," in which he described everything at the Cape except what he was sent to do. The work which Krosigk hoped to do then was not completed for another forty years, when Lacaille and Lalande made the necessary observations, the one at the Cape, the other in Paris.

MR. CARL ARMBRUSTER will begin a course of five lectures at the Royal Institution on "The Life, Theory, and Works of Richard Wagner," on Saturday, February 28 (with vocal and instrumental illustrations).

IN order to ascertain the truth of the assertions recently made by certain ichthyologists in regard to the capacity of Canadian salmon to exist in sea water, an experiment has been made in the South Kensington Aquarium, several specimens being deposited in one of the salt-water tanks, where they lived for eight days, when they expired in rapid succession. This entirely dissipates the theory which obtained credence hitherto in numerous quarters.

THE additions to the Zoological Society's Gardens during the past week include two Laughing Kingfishers (*Dacelo gigantea*) from Australia, two Hooded Crows (*Corvus corax*) from Connemara, Ireland, presented by Lady Brassey, F.Z.S.; a Sharp-nosed Crocodile (*Crocodilus acutus*) from Nicaragua, presented by Mr. C. G. Brown, M.R.C.S.; a Common Boa (*Boa constrictor*) from South America, deposited; a Cook's Phalanger (*Phalangista cooki* ♀) from Australia, a Globose Curassow (*Crax globicera*) from Central America, two Stanley Parrakeets (*Platycercus icterotis jv.*) from Western Australia, purchased; two Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

AN ANCIENT OCCULTATION OF JUPITER.—In Roger de Hoveden's Chronicle, under the year 756, we read:—"Eodem anno Balthere anachorita vitam sanctorum secutus est, et migravit ad Dominum; Luna autem sanguineo rubore superducta octavo Kalendas Decembris quindecima ætate, id e t plena, sicque paulatim decrescentibus tenebris ad lucem pristinam pervenit; nam, mirabiliter, ipsam lunam sequente lucida stella et pertranseunte tanto spatio eam antecedebat illuminatam, quanto sequebatur, antequam esset obscurata." (*Chronica Magistri Rogeri de Hovedene*, edited by William Stubbs, M.A., vol. i. p. 7.) Simeon of Durham records the phenomenon in similar terms, and also dates it in A.D. 756; but this has been long known to be a mistake, the eclipse of the moon, to which reference is made, having taken place on the evening of November 23, A.D. 755.

Calvisius at first supposed that the star which was occulted by the moon at the time of this eclipse might have been the "Oculus Tauri" or Aldebaran, and submitted the point to computation, though, as Pingré remarks, this was unnecessary, as a star with a latitude of more than 5° could not be occulted by an eclipsed moon. Struyck, in the first edition of his well-known geographical and astronomical treatise, published in 1740, stated that, on calculating the place of the moon, he had found there was no bright star near her at the time, and it occurred to him that perhaps the planet Jupiter might have been occulted by the eclipsed moon, which, on applying "Whiston's Tables," he ascertained to have been actually the case: the tables referred to were those of Halley in their early form. Struyck found the time of the planet's disappearance 6h. 30m. at London, and that of the reappearance 6h. 57m. (see Zach's *Monatliche Correspondenz*, i. 576).

The following results will probably supply a much closer approximation to the actual circumstances of the phenomenon recorded by the English historians.

For the elements of the eclipse of the moon we have—

G.M.T. of opposition in R.A., 755, November 23, 6h. 25m. 7s.

	°	′	″
R.A.	63	3	15
Moon's hourly motion in R.A.... ...		30	54
Sun's ,, ,, ...		2	41
Moon's declination	21	4	20 N.
Sun's ,, ...	21	16	37 S.
Moon's hourly motion in declination ..		8	8 N.
Sun's ,, ,, ,, ...		0	28 S.
Moon's horizontal parallax		54	16
Sun's ,, ,, ...		0	9
Moon's true semi-diameter		14	47
Sun's ,, ,, ...		16	16

The sidereal time at Greenwich noon was 16h. 7m. 34s. The moon was full at 6h. 30m.

From the above elements we find—

		h.	m.
First contact with the shadow	Nov. 23,	4	38
Beginning of total phase	,,	5	47
End of total phase	,,	7	18
Last contact with the shadow	,,	8	27

Employing Bouvard's Tables of Jupiter the following are the positions of the planet:—

Paris M.T. h.	Apparent R.A. ° ′ ″	Apparent decl. ° ′ ″
7	64 23 25	20 50 12 N.
8	64 23 3	20 50 9 N.

The log. distance of Jupiter from the earth was 0·6163.

Calculating the circumstances of the occultation for London, we find with the above data that the disappearance would take place at 7h. 35m., and the reappearance at 8h. 33m.; the former would therefore occur while the moon was still partially eclipsed, and the latter a few minutes after she emerged from the earth's shadow.

It may be mentioned that the moon's place has been determined in the same manner as for the occultation of Mars observed by the Chinese at Siganfou B.C. 69, February 14, and that of Venus, A.D. 361, March 20, at Nankin, the phenomena being well represented in both cases, as previously detailed in this column. No doubt the introduction of Leverrier's Tables of Jupiter would somewhat modify the times of disappearance and reappearance on November 23, 755, here given; our object has been merely to confirm Struyck's explanation of the recorded phenomenon.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *FEBRUARY* 22–28

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on February 22

Sun rises, 7h. 1m.; souths, 12h. 13m. 39·6s.; sets, 17h. 26m.; decl. on meridian, 10° 1′ S.: Sidereal Time at Sunset, 3h. 37m.

Moon (at First Quarter at 11h.) rises, 10h. 37m.; souths, 18h. 19m.; sets, 2h. 8m.*; decl. on meridian, 17° 8′ N.

Planet	Rises	Souths	Sets	Decl. on Meridian
	h. m.	h. m.	h. m.	° ′
Mercury	6 44	11 18	15 52	17 4 S.
Venus	6 30	11 5	15 40	16 54 S.
Mars	7 3	12 6	17 9	11 52 S.
Jupiter	16 56*	0 4	7 12	12 28 N.
Saturn	10 50	18 54	2 28*	21 36 N.

* Indicates that the rising is that of the preceding, and the setting that of the following nominal day.

Occultations of Stars by the Moon

Feb.	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
22	Aldebaran	1	17 17	17 50	20 336
23	130 Tauri	6	23 3	0 2†	145 288
26	B.A.C. 2872	6	15 59	16 24	340 286
27	α Cancri	4	4 1	4 53	104 303
28	B.A.C. 3407	6	5 24	5 37	187 216
28	π Leonis	5	6 5	6 45	147 253
28	35 Sextantis	6	23 59	1 4†	38 287

† Occurs on the following day.

It may be mentioned that times of disappearance and reappearance for the occultation of Aldebaran for various other positions in the United Kingdom will be found in NATURE, vol. xxxi. p. 322.

Phenomena of Jupiter's Satellites

Feb.	h. m.		Feb.	h. m.	
23	22 49	III. occ. disap.	27	1 51	II. tr. ing.
24	2 49	III. ecl. reap.		4 47	II. tr. egr.
	5 24	I. tr. ing.		18 16	I. tr. ing.
25	2 32	I. occ. disap.		20 35	I. tr. egr.
	4 57	I. ecl. reap.		21 38	IV. tr. ing.
	23 50	I. tr. ing.	28	2 11	IV. tr. egr.
26	2 9	I. tr. egr.		17 54	I. ecl. reap.
	20 58	I. occ. disap.		20 48	II. occ. disap.
	23 26	I. ecl. reap.			

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Feb.	h.	
23	8	Saturn in conjunction with and 3° 44′ north of the Moon.
28	12	Jupiter in conjunction with and 4° 27′ north of the Moon.
28	18	Mars at least distance from the Sun.

GEOGRAPHICAL NOTES

GEN. GORDON, when Governor of the Soudan in 1874, sent home to a friend a map of the route between Suakim, Berber, and Khartoum, drawn by himself. Mr. Stanford has reproduced this map in facsimile by permission, and it will probably be of great interest at the present juncture.

MR. STANFORD has recently issued two maps of the Soudan, in connection with the military operations which are at present being carried on in that region. These maps are most excellent, and must prove highly serviceable to all who wish to follow the course of events.

A VOLUME on New Guinea, which should be of great interest, is about to appear in Holland. The former Dutch Resident at Ternate, Mr. van Braam-Morris, in the course of his official tours on the Amberno or Rochussen rivers, succeeded in going a considerable distance to the south. His report, with the accompanying map, is now being prepared for publication by Mr. Robidée van der Aa, who is himself a high authority on New Guinea.

MR. A. M. SKINNER, Vice-President of the Straits branch of the Royal Asiatic Society, has published at Singapore, a Geography of the Malay Peninsula and the surrounding countries, in three parts, containing almost all that is known regarding the physical and political geography of these regions. The idea of the work was suggested by the Council of the Royal Colonial Institute, applying to the various Colonial Governments for school-books which might be used in schools at home for the instruction of pupils in the position, resources, and general progress of the Colonies.

IT is announced that Mr. Stanley's new work on "The Congo" will be published by Messrs. Sampson Low and Co. in April next.

UNDER the title of *O Explorador* (the Explorer) a Portuguese journal commenced its appearance with the new year at Lisbon. It will appear twice a month, and will chronicle the advance of science in all its branches, but especially that of geography and travel.

AT the meeting of the Geographical Society of Paris on the 6th inst. a letter was read from the French consul at Zanzibar describing recent events of geographical interest in Eastern Africa. Lieut. Gouin, Resident of France at Nam-Dinh, in the delta of the Red River, gave some information on the navigation and commercial resources of the southern mouths of the Red River. The most southern of all, the Cua-Day, is said to be navigable for sea-going junks, and to give immediate access to the richest rice-producing provinces of the delta. M. Léon Rousset read an account of a journey of eight months in Turkey. He dealt chiefly with the junction of the Turkish with the European railways.

ON A MODIFICATION OF FOUCAULT'S AND AHRENS'S POLARISING PRISMS

IN tracing by the usual methods the course of rays through one of the polarising prisms recently devised and constructed by Mr. C. D. Ahrens (described in the *Journal* of the Royal Microscopical Society for September 1884, and in the *Philosophical Magazine* for last month), I found that, in the case of a ray incident in a direction parallel to the axis of the prism, that component of it which passes through the middle spar-prism as the ordinary ray falls on the second surface of that prism at an angle of 42° 35′.

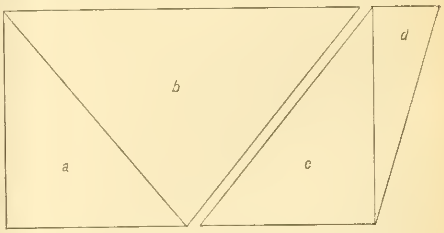
This is greater than the critical angle (37° 12′) for ordinary rays passing from calc-spar into air. Hence, if a film of air (as in Foucault's prism), instead of a film of Canada balsam (as in Ahrens's prism), is placed between this spar-prism and the next, the ordinary ray will be totally reflected, while the extraordinary component will still emerge and be available as a plane-polarised ray for experiments, as in Foucault's prism.

This extraordinary ray, however, is not only deviated on emergence, but also over-corrected for colour; the deviation from the direction of the original incident ray being—

For Fraunhofer's line	F	12° 20′
,, ,,	C	12° 35′

(as determined by using the light of a hydrogen vacuum-tube).

Both the deviation and the dispersion can be almost entirely corrected by passing the ray through a prism of crown glass combined with a prism of very dense flint glass, as shown in the drawing given below.



a, calc-spar; *b*, calc-spar; *c*, crown glass; *d*, dense flint glass.

What is said above respecting the ray incident parallel to the prism-axis applies to all rays incident at angles not greater than 14° with the axis; and thus the combination forms a polarising prism with an angular field of 28°, about equal to that of an ordinary Nicol's prism, and far greater than that of a Foucault's prism (which is only 8°).

The following points, among others, appear noteworthy in the above prism:—

(1) Its length is scarcely more than twice its breadth, the proportion between the two dimensions being rather greater than in

Foucault's prism, about the same as in Ahrens's prism, and much less than in Nicol's prism.

(2) Only half the prism is made of Iceland spar, a material which is becoming deplorably scarce and expensive (I question if there is in England or elsewhere a piece of spar fit to make a Nicol's prism of 5 cm. aperture). The saving, however, is not so great as it appears, since the spar-prisms *a* and *b* are constructed on Wollaston's principle, and involve a certain waste of material.

(3) The combination is not quite free from distortion and chromatic aberration (the latter being due, of course, to irrationality of dispersion; it is practically impossible to achromatise spar with glass), but the imperfection is not serious enough to interfere with its use for many optical purposes, especially as a polariser.

(4) In using it, a diaphragm should be placed in such a position as to limit the entering cone of rays to 28°, since at a greater angle (at any rate, on one side of the field) the ordinary rays are not separated by total reflexion.

Doubtless the prism may be improved upon by better authorities than myself; but I think that the principle of using a "double-image" prism to increase the divergence of the ordinary and extraordinary rays before one of them is separated by total reflexion is worth attention.

Ahrens's polarising prism is certainly a remarkable one. I do not think that a double-image prism has ever been previously constructed in which the extraordinary ray emerges without deviation, while the other ray is deviated to the extent of very nearly 60°.

H. G. MADAN

Eton College, February 17

THE RESULTS OF THE SCIENTIFIC EXPEDITION TO SODANKYLÄ

THE Government of Finland having provided further funds, the Expedition has continued its researches at Sodankylä, in Finnish Lapland, during the year 1883-84 (NATURE, vol. xxvii. pp. 322 and 389). The plan of working this year was chiefly confined to the study of the terrestrial galvanic currents, atmospheric electric currents, and the phenomena of light produced by the apparatus constructed by me for the purpose. The number of daily meteorological and magnetic observations was restricted to three, viz. at 6 a.m., 2 and 10 o'clock p.m., Göttingen mean time, but on the 1st and 15th of each month observations were taken every five minutes, as in the previous year, and on the 8th and 22nd of each month, from 8.30 p.m. till 10.30 p.m., observations were taken every half minute.

The general meteorological and magnetic observations were continued without interruption until August 22, 1884. In the account of the observations on the luminous phenomena will be included a *résumé* of the general character of the weather of this year.

The Terrestrial Current.—From the middle of September 1882 the Expedition has observed the terrestrial currents, as well as the magnetic variations. For this purpose two circuits about 5 km. long were placed north-south and east-west. They were connected to platina plates 1 decimetre square, and buried about 1·3 m. below the surface of the ground. The southern and eastern plates were about 0·5 km. from the station. During this year the observations were confined chiefly to the variations of the terrestrial current, hence no attempt was made to separate the electromotive force of the terrestrial current from that which was developed by the contact of the plates with the earth.

In the autumn of 1883 it became necessary to place fresh wires in the circuits, and at the same time the position of the plates was changed, so that each one was now about 2·5 km. from the station. The old circuit lying east and west was, however, left undisturbed for some time for the purpose of making comparisons.

It was not until the middle of January that observations of the terrestrial currents were commenced at the auxiliary station at Kultala, 68° 29′·5 N. (see Fig. 1). Here the circuits for the terrestrial current were placed so that the one lying north-south, 2·9814 km. long, was 3° west, and the east-west circuit, 4·5663 km. long, lay 69° north-west. This arrangement was made to permit the plates of the east and west being placed in the River Ivalo, and those lying north-south, in two affluents of this river. At this station attempts were made to eliminate that portion of the electromotive force which arose from the contact of the plates with "earth" (here the water) as well as the polarisation. The method employed was as follows:—With a Mascart electrometer, the sensitiveness of which had been exactly measured by a "Daniell" normal element (about 18 divisions of the scale per volt), the electromotive force of all the four plates in the earth was determined. These were then joined in six different ways with a galvanometer, and the deviations noted. A Daniell normal element, furnished with an adjustable resistance-slide, was then placed in the circuit in a contrary direction to the current, and the electromotive force was then reduced till the deviation was = 0. Thus the electromotive force of the different plates was obtained free of polarisation by means of an electrometer.

To eliminate the electromotive force arising from the contact

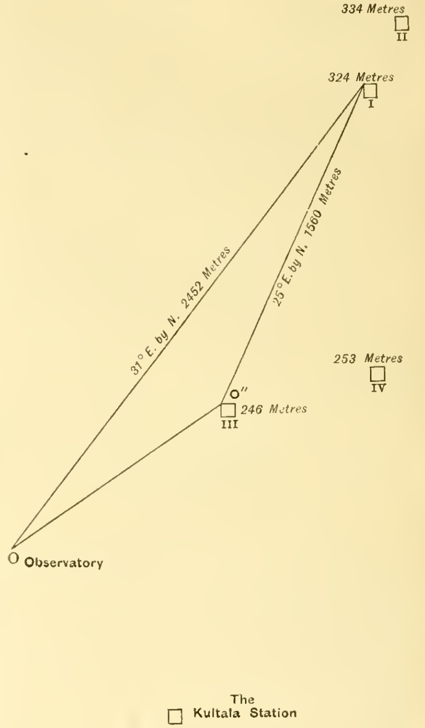


FIG. 1.—Plan of the position of the apparatus on the Pietarintunturi Mountains.

of the plates with the water, the latter were taken to the station and sunk in the river close by. They were connected with a wire from the circuits resting on Mascart insulators. Their electromotive force was examined by means of an electrometer, which was discharged each time by a plate of zinc amalgam sunk in the river. This experiment was also made in another manner. All the plates were sunk in a bucket of water resting on Mascart insulators and connected with the earth by a copper wire. The two latter experiments gave very similar results. When the platina plates had been examined in this manner, they were placed in their former positions, after which they were again examined both by the galvanometer and electrometer. The details of this experiment, as well as those of others, must, however, be reserved for a special memoir. By the above-mentioned means results are shown free from any accidental disturbing influences. Some observations, though as

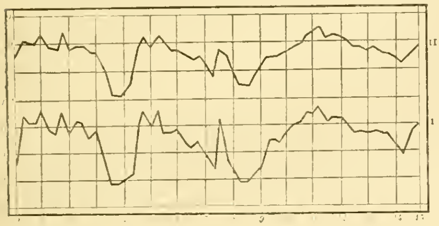
yet they have not been finally worked out, gave the following results:—

(1) When two galvanometers, as nearly equal as possible, were introduced into the two circuits lying east-west near Sodankylä, and which, as we have said, were moved towards each other so that the old circuit was 2·5 km. further east, the variations of the two galvanometers were *nearly identical.* This appears clearly from the graphic account of the deviations as they were observed on Oct. 16 from 5h. 25m. to 5h. 55m. p.m. (see Fig. 2). In the abscissa each centimetre represents two minutes, and in the ordinate each millimetre represents a deviation of 20 divisions of the scale, equal to an arc of 20′. The plates of the circuits in question having been sunk to a depth of 1·3 m., it is clear that the variations observed arose from changes in the electromotive force of the terrestrial current, and could not have their origin in the changes in the electromotive force arising from the contact of the plates with the earth, for had the latter been the case, the variations could scarcely have shown such extraordinary coincidence. Other similar experiments show, however, that small inaccuracies may occur.

The two curves do not correspond exactly in the intensity of the variations, which arises from the fact that the resistance of the old circuit was greater than that of the new.

While the variations which were greater and more numerous in an east-west direction occurred nearly always at Sodankylä, so that the needles of the galvanometer at that place were rarely at rest, the contrary was the case at Kultala, that is to say, the occasions on which the needles of the galvanometer were in motion were very rare.

As these facts were already observed by me in 1871 and 1882,



A B

Fig. 2.—Curve I. shows the deviations of the galvanometer in the old conductor. Curve II. shows the deviations of the galvanometer in the new conductor. Each centimetre of the abscissa indicates 2 minutes. The observations were made every half minute. Each millimetre of the abscissa indicates 20° of the scale = 20′ of an arc.

it seems fair to assume *that the North Pole of the earth is surrounded by a belt in which the terrestrial currents are stronger and more variable than they are north and south of this belt.*

The northern limit of this belt seems to be about 68° N. The position of this belt of terrestrial currents depends probably upon the belt of the aurora borealis.

(3) The magnetic variations and the changes which govern the terrestrial currents follow each other closely. We know that the former depend very much upon the aurora borealis, and that this dependence also influences the latter. However, the laws of this dependence cannot be determined until the materials of the observations have been fully analysed.

The Electric Currents of the Atmosphere studied by means of the Discharging-Apparatus.—Since Franklin and Dalibard proved—about the middle of the last century—by practical experiments that lightning is an electric phenomenon, many attempts have been made to measure the electricity which is always present in the atmosphere. These experiments have become more general since the discovery by Lemonnier, a Frenchman, that electricity was present in the air even without thunderstorms. Numerous methods have been invented and employed for examining this electricity, while all had for their object the measurement of the electricity present in a given spot at a given moment. In this manner the atmospheric electricity was carefully observed and registered, and by means of these records it was hoped to arrive at some definite conclusions. Sometimes researches were made to determine the variations of tensions in different directions, particularly the vertical direction. As a general result, but not without exception, these experiments showed *that the electrical tension* (or potential) *increased with the distance from the earth's surface.*

The knowledge of the electric charge, or the quantity of electricity present in a given atmospheric space, does not yet convey an exact idea of the electric phenomena which take place therein, but the knowledge of the variations accompanying it in different directions enable us to ascertain the *movements of the electricity*, or, in other words, *the electric currents of the atmosphere.* When we know by experience that the generality of effects, and the most important, which produce electricity arise from *electric currents*, it will easily be understood that the examination of the atmospheric electricity should have for its principal object the visible demonstration of these currents, and an explanation of the laws which regulate them.

The reason why the question has not as yet been studied from this point of view is probably that the air has been regarded as an insulating medium in which only momentary *electric discharges* occur, and not *electric currents.*

In the aurora borealis we have a "brilliant" proof of the existence of these currents, but up to the present the cause has always been sought elsewhere.

It is of course understood that a great number of *savants* have long been of the opinion that the aurora borealis was of electric origin. Having obtained, while with the Swedish Polar Expedition of 1868, some experience of electric phenomena in Arctic regions, I made some attempts during the expedition of 1871, near the church of Enare, to see if it was possible with the few means at my disposal to examine this supposed electric current (NATURE, vol. xxvii. pp. 322 and 389). I then succeeded, by means of a small discharging-apparatus, in demonstrating the presence of this current and in producing luminous phenomena, but, owing to certain external difficulties which I could not overcome at that time, these results are uncertain. During the year 1882–83 the Expedition at Sodankylä had occasion to make some similar but more extensive experiments, which were crowned with success, as I have previously stated in this journal (vol. xxvii. pp. 322 and 389). An electric current from the air towards the earth was proved to exist. Close to the village of Sodankylä we produced, by means of a large "discharging apparatus" or network of pointed conductors erected upon the summit of Orantunturi (1000 feet in height) a diffuse yellowish light, which, in the spectroscope, showed the ordinary auroral spectrum; and later on a veritable ray of the aurora borealis was produced on the Pietarintunturi Mountain, close to Kultala. On both occasions the electric current was measured.

Important as were the results of these experiments, they were, however, only of a provisional character, because, in carrying them out, difficulties of every description had to be overcome. In all these experiments the apparatus was connected with the earth by a wire leading to a zinc plate immersed in a well. Owing to the contact of the zinc with the water, an electromotive force was produced, and it was therefore probable that the current observed by the galvanometer might have its principal, or perhaps sole, origin in this electromotive force.

The expedition of 1883–84 was supplied with instruments for overcoming these difficulties as well as others, and has examined as closely as possible the laws which this current obeys.

After the arrival of the expedition at Sodankylä about the middle of September, a provisional apparatus was constructed on the mountain Komattivaara, lying 6 km. from the station, and about 437·5 feet = 129·7 m. high.

A conducting wire, supported by Mascart insulators, was placed from the apparatus on the mountain to the station, where it was joined to a galvanometer, which was connected with the earth by a plate of zinc (amalgam) placed in the neighbouring river. After some preliminary trials with this apparatus, which showed that, in spite of the lowness of the mountain, the atmospheric current could be examined, a "discharging apparatus," or network of pointed conductors, was erected upon a solid wooden structure, and was ready by October 19. The apparatus consisted of iron wires with welded points 0·5 m. apart. The wire was arranged in a series of squares 1·5 m. from each other, resting upon sulphuric acid insulators attached to poles which were nailed to a wooden frame. The wire with the points covered a surface of 364 square metres. With this apparatus extended experiments were made, chiefly relative to the different kinds of conducting plates to the earth, but space does not permit me to discuss these experiments here. The galvanometer showed a current from the *earth towards*

the atmosphere, *i.e.* from the zinc plate to the "discharging-apparatus."

For the future I will call this direction of the current *negative*, and the contrary direction from the atmosphere towards the earth *the positive*. The deviations of the galvanometer were very variable, and the variations characterised by sudden movements, first in one direction, then in another. With this apparatus observations were made at Sodankylä during last autumn and winter. The deviation of the current was first exactly noted, after which a Leclanché element was introduced into the conductor, first with the positive pole towards the earth, and then towards the mountain. By this process a value was obtained at each observation of the electromotive force in the circuit of the current. This consisted of two kinds, viz. one arising from the contact of the zinc plate with "earth" (here water), the other from the effect of the electricity in the air upon the apparatus. The first kind varies very little. Regarding the observations at Sodankylä it has been remarked that they showed, as I have said, a negative current, which however became sometimes positive in October and November, and particularly when the aurora borealis was visible.

The daily observations of the atmospheric current were made at Kultala in the same manner as at Sodankylä. During the months of January and February three more "discharging apparatus" were constructed close to this station, and another conducting wire was placed on Mascart insulators. Fig. 2 shows the position of the apparatus, whose elevation was as follows:—

Height above the River Ivalo		Height above sea-level
I. 324 metres	...	484 metres = 1630 feet
II. 334 ,,	...	494 ,, = 1664 ,,
III. 246 ,,	...	416 ,, = 1368 ,,
IV. 253 ,,	...	413 ,, = 1391 ,,

The distance between the station and the Apparatus I. was 3·626 km., and the distance between I. and II. 0·339 km. The following points are also shown by this sketch, viz.:—

O is a small observatory with a chimney; O″ is the point where the conducting wires of the four apparatus were joined to two wires leading to the station.

With this apparatus numerous experiments were made, chiefly in the month of March, of the results of which the following is a brief *résumé*:—

(1) If two "discharging-apparatus" are placed at a given elevation and connected with a galvanometer there is no current, *i.e.* the deviation of the galvanometer equals 0.

(2) The Apparatus II., connected by a galvanometer to Apparatus I., always gave a positive current, the strength of which varied considerably. The following values selected as examples show the electromotive force, expressed in volts, during four days in March:—

March 18	March 19	March 20	March 21
0·1171	0·1161	0·1891	0·0530
0·1714	0·1400	0·3262	0·0530
		0·2632	
		0·2632	

These values were obtained by introducing a Leclanché element into the conductor in opposite directions. The electromotive force of this element was determined by comparison with a Daniell normal element. As there was a difference of 10 m. in the height of Apparatus II. and I., it may be noted that the electromotive force varied during the above four days between 0·0326 and 0·0053 volts per metre. The above two results show, *that the electromotive force of the electric currents of the atmosphere may be studied with regard to their strength, and its variations by means of two "discharging-apparatus" erected at different elevations.*

When two apparatus at equal elevations give zero, it clearly shows that the electromotive force observed only depends upon the difference in elevation, *i.e.* that electricity is distributed throughout the atmosphere, so that an electromotive force is produced, causing a current from the atmosphere towards the earth. The continued study with these four apparatus gave this singular result:—

(3) Close to the earth there is a stratum of positively electrified air, the potential of which is greater than that of the immediately overlying stratum, so that the potential diminishes from the surface of the earth to a minimum, to again increase at higher altitudes. The Apparatus III. and IV. situated in this stratum gave, combined with I. and II., a negative current, *i.e.* from the earth to the atmosphere.

This result, so soon arrived at, rendered rather difficult the projected work with the four apparatus, and the difficulty increased still more owing to the fact that the conductive power of the air diminishes rapidly nearer the earth. In order to study more minutely this peculiarity, two portable "discharging-apparatus" were constructed, consisting of a cross of thin boards, on which were placed several spirals of wires provided with points, the total number of points being thirty. These miniature apparatus, which I will call S_1 and S_2, were erected near II. upon the most elevated point of Pietarintunturi, S_1 being 2 m. above the earth, and S_2 at the top of a pole 9·1 m. high. Both were supported on Mascart insulators, and separately connected with the stations by conducting wires. With this apparatus a current was obtained from S_1 and S_2, *i.e.* negative, from the earth to the atmosphere. Great care was taken against any accidental defect in the conductor, or in the arrangement of the apparatus. The deviation obtained was very small, but quite measurable. The actual experiments with these apparatus were made on March 26 at 11 p.m., and lasted about three hours. As these experiments are of great importance I will describe the method followed.

The night was chosen as the most favourable time, the wind on the mountain being then very slight. The observers, Messrs. Granit and Roos, having telephoned that the experiments could commence, the current was measured by the galvanometer, S_1 being then 2 m. and S_2 at 9·1 m. above the earth; *the deviation was negative*. S_2 was then lowered to the same height as S_1, when *the deviation was* 0. S_2 was elevated to its former position, and now the deviation was negative as originally. S_1 was now attached to two poles—3 m. high—furnished with Mascart insulators, and then raised by two men to a height of 4 m. *The deviation now became positive.*

This proved that the electric density of the stratum of air diminishes up to the point at which the current changed, and that the minimum density lay between a height of 2 m. and 4 m.

It would have been very interesting to have continued these experiments and further extended them, but this could not be done, as the stay on the mountain became impossible.

I went up on March 25 to examine the apparatus and convince myself that no mistakes had been made, and although the temperature was not more than − 12° C. it was impossible to work except with the back to the wind, for if the face was turned towards it, in a few moments the flesh became benumbed, and breathing difficult and painful. On the mountain there was nearly always wind, but its strength was less at night.

These experiments with the portable apparatus will be resumed next spring at Sodankylä under the superintendence of Mr. Biese, but as it is very probable that the electric state of the atmosphere will then be totally different, it is impossible to foretell whether they will give the anticipated results.

(4) From the stratum which lies some feet above the earth the electromotive force increases with the differences in height of the "discharging-apparatus." It has not been possible to determine exactly the laws which regulate this increase, but it is believed that the electromotive force increases more rapidly than *in proportion to the difference in height.*

The above results were obtained on clear days. The moisture of the atmosphere affects the resistance of the conductors, and appears also to act upon the electromotive force.

On one of the small apparatus, S_1, a number of points were furnished with wicks soaked in petroleum; when these were lighted the effect was measured, and it appeared that the resistance diminished a little, but the electromotive force remained unchanged. Further results obtained from the observations must depend on a detailed examination of the materials collected.

Study of the Luminous Phenomena caused by the "Discharging-Apparatus."—Before passing to a final *résumé* of the results of these researches, I will refer in general terms to the meteorological character of the year, which are very important in relation to this subject. It is very seldom that the winter in Lapland is so mild as the last one was. There was not much rain or snow, but it snowed nearly every day, so that the days when there was a clear sky can easily be counted. It is only in perfectly clear weather that the luminous electric phenomena are visible, and this only happens when the moonlight is not too brilliant. Consequently there were very few evenings when the luminous phenomena could be successfully observed.

Another remarkable circumstance proves that the electric forces worked under abnormal conditions, viz. by the small number of auroræ appearing, which does not amount to one-tenth of the normal number according to the latitude, and except in three cases their intensity was very feeble. The cause thereof is to be found, I believe, in the constantly falling snow and the comparatively high temperature. Even the diffuse luminous phenomena which were seen so often during the winter of 1882-83 (see my former report), and which gave the spectral reaction of the aurora borealis, were very rare.

In fact, according to all reports, the characteristics of this winter are quite contrary to the preceding one, which is the more surprising as we are now in a maximum period of auroral manifestations. There have indeed been very few evenings on which the luminous phenomena could be studied, and the best of them have nearly always been accompanied by a full moon. The contributions which the expedition has been able to make to the study of these phenomena are therefore relatively small, but sufficiently important. We know from our former experiments that the "discharging-apparatus" *produces* a *luminosity*, sometimes in the form of a cloud-light, sometimes in *rays* which rise above the apparatus. The diffuse luminosity which always gave the spectral reaction of the aurora was produced very easily. *It was distinctly seen above the apparatus at Sodankylä, sometimes even with the naked eye, and very often with the spectroscope.*

As early as the autumn of 1882 Mr. Biese discovered that it was possible to obtain a spectral reaction of the aurora to the south-south-east of Sodankylä, a few degrees above the horizon, in the direction of the mountain Luostatunturi, while to traces were visible elsewhere. During the autumn of 1883 the same reaction was sometimes obtained from the mountain Komattivaara, although it could not be perceived in the above-mentioned direction. This luminous phenomenon was also very distinctly observed on the following nights, viz.:—

On the evening of November 1, when a strong wind from the west had chased away the clouds, an aurora was seen which commenced with a fairly regular arc in the north-north-west. The arc touched the eastern horizon at about 20° north of Komattivaara. While the reaction was obtained along the whole length of this arc, it entirely disappeared at this point of 20° from the horizon between the foot of the arc and the mountain. Moreover, this was distinctly shown as the slit of the spectroscope was directed towards the discharging-apparatus. On the southern side of the mountain the reaction again disappeared completely. As a general rule, the study of this luminous phenomenon was made at a distance of 5 km., but on two occasions rather closer. On November 12, in spite of the moonlight, moist air, and snow, a distinct reaction was obtained at a distance of 1 km. That evening the phenomenon was very brilliant, appearing like a moving luminosity along the whole apparatus, with a diffused radiating fan of light above. It was observed for fifteen minutes.

At Kultala the luminous phenomena were generally of greater intensity, but the majority of them could only be seen by means of the spectroscope, chiefly because on the most favourable occasions the moonlight was too bright. In order to obtain another proof of the electric origin of the aurora borealis, the expedition was furnished with a double Holtz machine, which, in spite of its fragile construction, arrived safely at its destination. When this machine was connected with the circuit of Apparatus I., with the positive pole towards the earth, the luminosity was more distinct. This was noticed as early as December 17 at Sodankyla, when the machine was connected with the conductor from Komattivaara, but the more exhaustive studies were made at Kultala. The observations, which were always made from the house o (see the sketch), have the following dates, viz.:—1884: January 27, February 3, 4, 6, 7, 8, 12, 16, 20, 24. They were made by Mr. Biese and myself, and we have a report of each evening, that of February 3 being written by me, the others by Mr. Biese. We detail below those of February 3 and 7.

February 3.—Arrived at the Observatory at 6.30. The moon had risen, and shone brightly on the tops of the mountains; no trace of the aurora could be seen either by the naked eye or the spectroscope. At a telephonic signal the Holtz machine was connected with the conductor, the positive pole being placed towards the earth. But in spite of the closest attention no trace of auroral light could be discovered. Presently, however, the moon became covered with a haze (nimbus), and the brightness of its rays diminished by one-half; when this had lasted about half an hour, a luminous phenomenon in the shape of white clouds rose in flames from Apparatus I. *This gave the reaction in the spectroscope, and was very distinct, even to the naked eye.* At a signal, the machine was again put in motion, and now the flames followed each other every time, giving the reaction in the spectroscope. This reaction had sometimes a certain peculiarity: although the slit of the spectroscope was very straight, the line of the aurora was rather broad, and was followed by a continuous and very distinct spectrum towards F. At eight o'clock the machine was stopped, and the flames became fewer and feebler. At 8.15 p.m. the machine was again put in motion, with the same result as before. Presently a fog covered the summit of the mountain, and the experiments ceased at 8.40 p.m.

February 7.—The clouds were about 5 C S. (5/10 cirro-stratus), hence the reactions could only be obtained as projections upon the bright spectrum of the moon. Now and then a very feeble reaction was obtained towards the north and west, but the Apparatus I. gave none of them. However, when the Holtz machine was put in motion, a very distinct one was obtained, particularly when sparks were emitted. After a Geissler tube had been placed in the conductor of the machine the reaction became still more intense, and was very distinct when the discharge was accompanied by sparks. Never had I obtained so intense a reaction. Mr. Biese again remarked that no absorption-band had been observed near D in the spectrum of the moon, although its intensity varied considerably. From these data may be inferred:—

(1) That the "discharging-apparatus" produces on certain occasions a diffuse light which gives the spectral reaction of the aurora borealis.

(2) That a Holtz machine placed in motion in the conductor intensifies the phenomenon, if it already exists, and may even produce it under favourable external conditions.

(3) This luminous phenomenon is invisible to the naked eye if the moonlight is very bright, but even then the spectroscope often shows its presence.

After my experience of the power of the "discharging-apparatus" to produce luminous phenomena in the *form of rays*, I thought the phenomenon would appear easily. The following conditions are however, I have discovered, necessary for this: *a clear sky*, *low temperature*, and a *relatively low barometer*. These conditions have been very rare this winter, and when they have been present it was in an imperfect manner. However, the phenomenon was seen twice, viz. on February 27 and March 2, according to the following reports by Mr. Roos:—

February 27, 1884.—From the point o a feeble auroral arc was observed extending from west to north-north-east, the intensity of which gradually increased. At the same time there appeared in the direction of Pietarintunturi, above the arc but not connected therewith, a sheaf of very intense rays, which moved rapidly westward and disappeared after passing the northern line. Not a single ray was visible in any other part of the sky.

March 2.—Messrs. Granit, Ross, and myself observed from this point an aurora which rapidly increased in intensity, and formed a corona as early as 8 o'clock. I immediately went to point III., in order that the luminous phenomena which might appear above the apparatus at Pietarintunturi might be observed from two points simultaneously. About 10.30 I perceived a very intense ray in the direction of Apparatus I., leaning at first a little to the east, but rising by degrees like a radiating sheaf, with a slight westerly direction. The phenomenon lasted from thirty to forty seconds. On telephoning to Mr. Granit, who remained at point o, he replied that no luminosity was visible above the apparatus. Afterwards, and at short intervals, I three times saw a feeble ray in the same direction, but of different aspect. The ray, which was vertical, appeared of equal size and of a pale yellow colour. Although feeble it was very distinct. According to Mr. Granit no rays could be observed from point o, either above the apparatus or around the mountain for a space of about 15° on either side, and on this occasion the moonlight was very bright, which, together with the intense aurora, rendered the observation of the luminous phenomena very difficult, and besides this, the distance from o to I. is 2·45 km., while from III. to I. it is only 1·56 km.

If any doubt remained as to the first observation, *i.e.* as to whether the rays were above the mountains or not, the second, taken on March 2, is quite conclusive. If Mr. Granit could perceive no rays at point o, at a distance giving an angle of 15°

at two sides of the mountain, that merely proves *that the light was too feeble to penetrate a distance of* 2·45 *km.*, though it was visible at 1·56 km. The reflection of the moonlight was also stronger at point O than at III., because on this occasion the moon was nearly north east.

It is not easy, I confess, to make a *résumé* of the results arrived at by the researches of the Finnish Expedition to Lapland concerning the electric currents of the earth and the atmosphere, chiefly owing to the circumstance that the materials are not as yet fully analysed, but the following may, however, be accepted as quite certain, as they are based on actual observations:—

The aurora borealis, which has long been a disputed enigma, is the result of an atmospheric electric current.

This auroral current can be measured, and, as a rule, studied, by the methods employed by the Expedition.

The "discharging-apparatus," or network of pointed conductors, used by the Expedition, has very often produced a diffuse light which gave in the spectroscope an auroral spectrum. Under very favourable conditions the light appeared in the form of rays above the apparatus.

With a Holtz electric machine the diffuse light may be *produced* under favourable conditions, and if it exists already it may be considerably intensified by the same means.

For the study of terrestrial electric currents a method has been found which, while avoiding all foreign influences, permits of the current being measured, both as regards absolute strength and as regards the exact laws which regulate it.

From these experiments it seems that the existence of a belt of terrestrial currents similar to the belt of auroral currents is very probable. SELIM LEMSTRÖM

Helsingfors University

ON THE NATURE OF LICHENS

IN the *Journal* of the Linnean Society for December 12, 1884 (Botany) there appears a review of the "Algo-Lichen Hypothesis," by the Rev. J. M. Crombie, F.L.S., from the strongly conservative point of view of Nylander, on which I desire to make a few remarks as a critical student of Botany at large.

Mr. Crombie cites, as a fatal objection to Schwendener's hypothesis of symbiosis between the lichen proper and the alga forming its gonidia, that in other cases of vegetable parasitism "the hosts usually become speedily exhausted and finally perish, often involving in their death that of the parasite itself;" whereas here we have "a parasite exceeding in size and number of cells by many hundred times the nourishing plant which it invests." It is now over six years since I sent you, with reference to this very point, a brief note on the subject, which probably escaped Mr. Crombie's notice by its brevity, and of which I reproduce the substance. The essential elements of nutrition of a fungus, so far as we can judge from culture experiments, are as follows:—(1) *ash constituents*; (2) *nitrogen* in the form of nitrates, nitrites, or ammonia; (3) *carbon and hydrogen combined* in the form of tartrate, carbhydrate, or fat, &c. An alga requires only Nos. 1 and 2, deriving No. 3 by assimilation from the carbon dioxide of the atmosphere and water. The lichen hyphæ, aided by excretion of carbon dioxide, can dissolve the ash constituents, No. 1, from the substratum, taking them up by the rhizoids; the rain probably brings No. 2 in the form of traces of nitrates; No. 3 can only be formed by assimilation in the algal part or gonidia of the lichen. But, to obtain the carbhydrates, No. 3, there is no need for the hypha to penetrate the gonidium or to molest its protoplasm, as the algal cells have a cellulose wall, of which the outer layers undergo constant gelification and renewal. Into this it is that, as shown by Bornet ("Sur les Gonidies des Lichens," *Ann. Sc. Nat. Bot.*, ser. 5, xvii.) the hyphæ penetrate; and if they only lived on this, once formed, there would be no strain whatever on the resources of the alga. But, even if they stimulate an abnormally rapid cellulose formation, the injury need not necessarily be severe. We see oysters living well, though their shells are burrowed by the sponge Cliona; they produce new layers of shells far faster than when they are sound, but are otherwise uninjured.

An unlooked-for confirmation of these views is found in Johow's account of the Hymenolichenes (in Pringsheim's *Jahrbücher*, xv., part 2), where, "*in consequence* of the unusually close and perfect investment of the gonidia" by the hyphæ, the gelatinous investment of their cell-wall completely disappears. This is in marked contrast with the usual state of things as figured by Bornet.

De Bary puts the case thus:—"With their growth (of the algæ) the assimilation of carbon dioxide persists in their protoplasm with its chlorophyll, and produces organic carbon compounds utilisable by the fungus. At the same time the rhizoids of the fungus ramify on and in the substratum, and bring the mineral pabulum required. These two processes support and complement one another (*Vergleichende Morphologie u. Physiologie d. Pilze*, &c., 1884, p. 425).

It is further noteworthy that, if the growth in size of the gonidia is often favoured by their inclosure in the lichen-thallus, their rapidity of multiplication by division is notably impeded; while spore-formation, &c., remains in complete abeyance.

Mr. Crombie recalls the absence of algæ in places where lichens abound, *e.g.* "granitic detritus and boulders towards the summit of lofty mountains." This follows from the fact that the algæ alone cannot there obtain, unassisted, their papulum No. 1, the mineral substances or ash constituents. The absence of the fungi *alone* from these localities simply shows that they cannot live without their algal gonidia.

Mr. Crombie gives as an essential distinction between the hyphæ of lichens and those of fungi the character of their cell-wall: "perennial, firm, penetrated by lichenin, thick, imputrible, and insoluble in caustic potash in the former; caducous, very soft, with thin walls, readily putrifying on maceration, and, on the application of caustic potash, immediately becoming dissolved."

As regards the thickness and permanence of the walls, it needs hardly to be recalled how much this character varies in different parts of the same fungus, and notably in corresponding organs of different members of the same group of fungi: compare *Polyporus* and *Boletus*, *Schizophyllum* and *Coprinus*. As to the presence of lichenin, De Bary states (*op. cit.*, p. 10) that in at least three gelatinous fungi—*Hydnum erinaceus*, *Polystigma*, and *Hysterium macrosporium*—the hypha turns blue on the application of aqueous solution of iodine, that is, gives the "lichenin reaction."

As regards the alleged solubility of fungus hyphæ in caustic potash, I am at a loss to understand it, having, like most workers, been in the habit of using this reaction "for clearing" vegetable preparations to demonstrate the presence of parasitic fungus hyphæ, which would be impossible if it dissolved them. And I find no account of this solubility of fungal cell-walls in Hofmeister's very complete "*Lehre von der Pflanzenzelle*," or in De Bary's above-cited work.

A misapprehension on the part of the author is to think that the Schwendenerian school have overlooked the "cellular cortical layer" when they speak "as if only two elements entered into the structure of lichens, viz. hyphæ and gonidia." This is due, so far as it is true, to the general recognition by mycologists that such pseudo-parenchyma as that composing the cellular cortical layer of lichens, of fungus sclerotia, &c., is only an extreme modification of the hyphæ. But, far from being ignored, it is figured and described by Sachs ("Text-Book of Botany," (1st Engl. ed., Figs. 188, 189, and explanation), who says: "The upper and under cortical layers [of *Sticta*] also consist of hyphæ, which, however, . . . consist of shorter cells, and are united without interstices, forming a pseudo-parenchyma." Its formation is also described by Bornet (*op. cit.*, p. 97), and De Bary writes (*op. cit.*, p. 436): "The hypha-branches forming the cortical layer ('Rindenschicht') are united without interstices, save in certain species of *Rocella*. They are either recognisable as such, having the lumina of their segment-cells evidently elongated and cylindrical, even though shorter than those of the medulla, or else they are formed of short isodiametric rounded prismatic cells, giving the cortex the structure of a pseudo-parenchyma, which is often extremely regular and neat ('*zierlich*'). . . . The structure of these cortical layers shows great similarity to that of many sclerotia."

In the latter half of the paper Mr. Crombie exposes at length the view that the gonidia originate in the cellules of the hypothalline and cortical layers,[1] and illustrates it by figures. In this no attempt is made to show the part played by the protoplasm in the process, an omission which is an implied confession of the inadequacy of the weapons, optical and technical,

[1] As regards his statement that "specimens illustrating the earlier stages of lichen growth appear to be unknown to the supporters of Schwendenerianism," it is only necessary to revert to Bornet's paper, p. 97.

employed in the investigations on which the view is based.[1] Considering that chlorophyll bodies and plastids generally are unknown in hyphæ of all kinds, and in view of the recent researches on the part played by nuclei in cell formation, we had a right to expect some allusion to these matters in a research dated 1884. As regards the optical powers employed, two instances will suffice. Fig. 7 is stated to be highly magnified; 7*a*, a more highly magnified part thereof, is only enlarged 275 diameters, and this is the highest power used! Fig. 7*a* is stated to show "the separated gonidia [of *Psoroma hypnorum*] inclosed in the cellules [of the cortex], after Nylander." It represents, in fact, a homogeneous green spot separated by a narrow blank space from the concentric double black outline. Fig. 2*a*, "Gonidia [of *Lecanora gibba*], as seen inclosed in the cellules of the pseudo-parenchyma, magnified about 270 diameters," only differs from 7*a* in the black outline being single instead of double; and these two figures are the only ones professing to illustrate the actual formation of the gonidia!

So much for the formation of the gonidia from the hyphæ or the derived cellular cortical layer. Of the inverse origin of hyphæ from gonidia, the author gives no hint; yet, surely this should be taken into consideration also in a complete account of the lichen as a simple organism? Mr. Crombie states that "*Sirosiphon*, *Hormosiphon*, *Scytonema*, *Stigonema*, *Cora*, *Dichonema*, *Chroolepus* or *Trentepohlia*, *Nostoc* and *Glœocapsa* (at least in part), *Gongrosira* and *Phyllactidium*, have now to be removed from the class of the algæ," having, "in consequence of the discovery of their fructification, been proved to be lichens." Such papers as those of Bornet and Johow are in complete discordance with this view, except as regards *Cora* and *Dictyonema* (or *Dichonema*). Mr. Crombie seems to be unaware that the discovery of a *hymenomycetous* fructification in these very genera of lichens by Mattirolo ("Contribuznione allo Studio del genere *Cora*," in *Nuov. Giorn. Bot. Ital.*, vol. xiii. 1881), confirmed and extended by Johow, is regarded by most botanists as the very coping-stone of the symbiosis theory founded by De Bary and Schwendener; but their papers are not referred to.[2]

I may say that I have personally hunted through many a *Nostoc* colony without finding a trace of hyphæ; and there is no record of the transmutation of a *Nostoc*-cell into a lichen or fungus hypha. Yet this is wanting to show that *Nostoc* is the immature form of a lichen. So I have frequently seen *Glœocapsa* colonies permeated by hyphæ, which could often be traced to septate (probably lichen) spores, but, like all other observers, never to a green cell. *Gongrosira* has been demonstrated by Stahl to be at least in part the resting form of *Vaucheria* ("Die Ruhezustand der *Vaucheria geminata*," in *Bot. Zeit.*, 1879, p. 129, t. ii.), and must henceforward rank only as a form-genus. *Phyllactidium* is another form-genus, comprising young forms of genera so distinct as *Coleochæte* and *Mycoidea*, Cunn.

I have abstained from reviewing the purely critical appreciation of the works of Schwendener, Bornet, Rees, Stahl, &c., though Mr. Crombie's treatment thereof seems to me decidedly offhand. But I trust that in my remarks on his positive arguments in favour of the unitary theory of lichens, I have not exceeded the bounds set by the respect all must feel towards his honest and arduous work on the classification of so difficult a group. MARCUS M. HARTOG

Queen's College, Cork

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—A temporary Pathological Laboratory has been fitted up for Prof. Roy, and it is proposed to vote 400*l.* for apparatus.

Downing College has now a capital opportunity of appointing a scientific man as Master, owing to the death of Dr. Worsley.

Mr. C. Dixon has been appointed a Demonstrator of Mechanism and Applied Mechanics in place of Mr. J. H. Nicholls, resigned.

A discussion took place last Friday on the Report as to a new Chemical Laboratory. Prof. Liveing stated in forcible terms the inadequacy of the present laboratories, which were inferior to those of many schools. He could not classify students; he had no class-rooms, and literally no provision for research. Cambridge was subjected to severe competition; a new University in the north of England was supplying considerable means of research; and before long it must be expected that the plans for a Teaching University for London would be carried out. It would be economical to make good provision while they were about it. The estimated sum of 30,000*l.* was as low as would provide suitable accommodation. The chief objections urged against the proposal were as to the magnitude of the sum in proportion to other requirements and to the funds at the disposal of the University. Prof. Humphry made a vigorous appeal to men of wealth, who might find in Cambridge many objects worthy of their munificence. Cambridge laboured under the double disadvantage of being poor and of being thought rich.

THE following courses of Lectures and Demonstrations in special branches of Physics will be given in the Physical Lecture Room and Laboratories of the Science Schools, South Kensington:—(1) Connection between Sound and Music. Six Lectures and Demonstrations by R. Mitchell, at 2 p.m. on February 23, 25, 27, March 2, 4, 6. (2) Certain Optical Measurements. Eight Lectures and Demonstrations by H. H. Hoffert, B.Sc., at 2 p.m. on March 9, 11, 13, 16, 18, 20, 23, 25. (3) Electrical Measurements. By C. V. Boys, A.R.S.M., at 2 p.m. on April 13, 15, 17, 20, 22, 24, 27, 29; May 1, 4. (4) The Chemical Action of Light. By Capt. W. de W. Abney, F.R.S., at 2 p.m. on May 6, 8, 11, 13, 15, 18, 20, 22. The above courses are open without fee to all second and third years' regular students of the Normal School of Science and Royal School of Mines, on their giving to the Registrar a written recommendation from the Professor or Lecturer whose classes they are attending at the time. The fee to others attending the courses are: for each separate course, 10*s.*; for all the courses, 30*s.* Such fees are payable in advance to the Registrar of the Normal School of Science and Royal School of Mines. These courses will only be given if a certain number of applications are made a week before February 23. Those intending to join are therefore requested to do so as soon as convenient. All the courses are open to women.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, January 29.—"On the Structure and Development of the Skull in the Mammalia. Part III. Insectivora." By W. K. Parker, F.R.S.

Although this paper is confessedly only a fraction of what is necessary to be done in this polymorphic order, it shows at least how difficult a group it is to handle. For the Insectivora are set in the midst of the other mammalia—low and high. They might be called the biological stepping-stones from the Metatheria to the Eutheria.

One thing can be done, even now, with our present fragmentary knowledge of the structure and development of the insectivorous types—we can assure ourselves that these types are immediately above the Marsupials, that they have the bats (Chiroptera) obliquely above them, that their nearest relations must be sought for amongst extinct Eocene forms, and that, lowly as they are, and arrested and often dwarfed to the uttermost (so that nature could not safely go further in that direction), they are rich in prophetic characters that have come to perfection in larger and nobler types.

I think it will not be denied that in the ascent of the types the Chiroptera are above the Insectivora, and, as it were, a sort of special "new leader" from that stock, and that the Insectivora are more or less transformed modifications of the marsupial type. I suspect that the existing Insectivora just yield the zoologist one of his groups of types classed together because he knows not what else to do with them; they are not a proper, clear, special branch or "leader" of the mammalian life-tree. They form one group under one designation, just as the *poor* of this metropolis form a group; their special mark is simply lowliness; they differ *inter se* almost as much as the whole remainder above them differ. The higher forms, however, because of their elevation, can afford to be sub-divided again into order after order. If we could descend and see the transforming and newly transformed Placentalia of the Eocene epoch, then the morphologist and the zoologist would find common ground; the taxonomy of the latter, however, would be as useless as the titles and distinctions of modern society to some undeveloped race of savage men.

The best type of Insectivore for general comparison is the

[1] The wonderful results obtained by Mink and Müller in their researches on the "Microgonidia of Lichens" show that *high powers alone* do not suffice for scientific investigation. Mr. Crombie has rightly rejected their views.

[2] Johow's could hardly have reached England before the composition of Mr Crombie's paper. Mattirolo's dates from 1881.

hedgehog (*Erinaceus europæus*), as it shows the least suppression of parts, and the best development of that which is diagnostic, so to speak, of the order. In it the great investing bones of the skull are similar to those of the marsupial, but the nasal and squamosals are smaller, and the frontals are larger. In the hard palate there is a considerable relapse, as in marsupials, certain tracts of bone being absorbed, but it has no mesopterygoids, and only *five* vomers, yet the anterolateral pair are well developed. Moreover, the tympanic region has only one annulus, the outer bone; there is no separate os-bullæ. Instead of the latter there is a crescentic shell of bone which grows from the basisphenoid, greatly increasing the size of the tympanic cavity. In the endoskeleton in front of the tympanic cavity there is a remarkable ridge of bone growing outwards from the alisphenoid. That ridge is the remnant of the alisphenoidal tympanic wing of the marsupial, and the shell of bone growing from the basisphenoid is the same morphological element as the separate os-bullæ, but it has lost its independence. The higher mammalian type is fully reached in the thorough freedom of the alisphenoid from the general cranial wall. This character, indeed, is intensified into the special diagnostic of an insectivore, for it lies almos, wholly outside the orbitosphenoid. Here the sphenoidal fissuret which in this case lets out the second branch of the fifth, but not the optic nerve—that nerve having its own foramen in the orbitosphenoid—is not a mere gap, but a *side passage*, or a sort of sphenoidal corridor, right and left. In these things the hedgehog is higher than the marsupial, but in some others it is lower, or more archaic. These latter characters, which suggest an uprise from a more general type than the existing metatheria, are—

(1) The development of solid hyaline cartilage in the pterygoid region, a remnant of the pterygo-quadrate of the Ichthyopsida.

(2) The presence of a persistent pituitary hole, which is connected with a curiously specialised structure only seen in typical insectivores, namely, a hollowing out of the basis cranii beneath the pituitary region.

(3) A third archaic character, not seen in the existing marsupials, is the huge relative size, long persistence, and separate distal ossification of Meckel's cartilage, so that in the embryo hedgehog, and even in the nestling, the primary lower jaw is as large as in fishes generally, scarcely excepting the Selachians.

The ossicula auditûs are typically Eutherian; we have lost the imperforate stapes or columella, the interhyal is very small or absent, and the malleus and incus are much like what we find in the higher mammals generally. The pneumaticity of the skull is much reduced: the olfactory region is almost double the relative size of that of a Marsupial. In the head of another family of the Insectivores, namely, the mole (*Talpa europæa*), there is much that is in accord with what is found in its distant relation, the hedgehog, but in it there are evident signs of degradation and of relapse into what is Marsupial in character. The nasal labyrinth is relatively immense, and the skull-walls below, laterally, and behind are as exquisitely pneumatic as in the flying Marsupial (*Petaurus*), the bird, or the crocodile. The swollen basis cranii, all air galleries within, is so excavated that the hinder sphenoid, both base and wings, largely helps the flat single tympanic to form the drum cavity. The pituitary hole does not exist, but there is a considerable pterygoid cartilage. The ossicula *in the adult* are normal, but a curious special character is seen in the ossification, in the young, three parts grown, of the sheath of the stapedial artery, which for a time holds the stapes in its place. It is, however, absorbed afterwards, but remains in the related genus *Myogale*. In nearly half-grown young moles the malleus is quite like that of the marsupials; it is an evident "articulare," with copious wild growths of bone, sub-distinct, which answer to the "angulare" and "supra-angulare" of a reptile or bird. This malleus in its articular part has two endosteal and one ectosteal bony centre.

Meckel's cartilage, long continuous with the malleus, is nearly as massive as in the hedgehog, and has a more distinct separate ossification in its sub-distal part, a long, independent, but temporary *hypobranchial bone*.

The mole shows a most remarkable development of the endocranium, which, twenty years ago, suggested to me that its skull retained unmistakable monotrematous characters. In large young of the *Echidna* and *Ornithorhynchus* the solidity of the chondrocranium is immense, like that of a *Chimæroid* Selachian. and the investing bones are thin and splintery. I have not made out the mode of ossification of the inner skull in those types, but in *spirit*, if not in the *letter*, the mole agrees with them, that is, in the great development and independence of the inner skull. The opisthotic bone ossifies the normal petro-mastoid region, whilst the prootic bony centre begins in its right place on the front edge of the cartilaginous capsule, and then runs away from it into the wall of the skull. Thus there is a large bony tract in the temporal region between the squamosal and the large interparietal, which is not one of the ordinary ectocranial bones, but an endo-cranial bony tract overshadowing and yet imitating the true temporal bone or squamosal. This bone is represented by three separate centres in osseous fishes, namely, the prootic, pterotic, and sphenotic, whilst their true auditory region is partly ossified by the epiotic and opisthotic; the epiotic is only sub-distinct in the mole. If I am asked why I dive so far down for my illustrations, instead of being satisfied with what reptiles and birds would show me, my answer is that these are often of no use for comparison, as they are as thoroughly specialised for their own mode of life as the Mammalia generally, and are as completely, and often more completely, transformed from the original archaic type or types. Thus the mole, like most of the Edentata lately described by me, suggests as the root stock of the Eutheria generally, not marsupials (Metatheria), as we know them, but prototherian forms in which, in ages long past, the existing monotremes and marsupials had a common origin. The shrew (*Sorex vulgaris*) represents another family of the Insectivores, the Soricidæ. It combines the characters of the mole and hedgehog with peculiarities of its own that are manifestly due to dwarfing; many things are suppressed, as if there was not room in so small a skull for their development. The pituitary hole reappears, and the pterygoid cartilage, but the tympanic wings of the alisphenoid and of the basisphenoid are gone. The malleus does not show itself so unmistakably marsupial, and Meckel's cartilage is slenderer. The sheathing alisphenoids are well seen, the squamosal is extremely small, low down, and devoid of a jugal process; the jugal bone is suppressed. The prootic wing is present, as in the mole.

So much for the British representatives of these families of the Insectivora—the Erinaceidæ, Talpidæ, and Soricidæ. The Mascarene Insectivora are so evidently related to each other as to suggest at once a common origin; these are the Centetidæ, the largest of which is the Tenrec (*Centetes ecaudatus*); the other genera treated of in this paper are *Ericulus*, *Hemicentetes*, and *Microgale*.

These are almost typical Insectivora, but they agree with the shrews in having the jugal bone suppressed; they are also more marsupial than our native kinds. In these types the normal characters of the skull of an insectivore are combined with a remarkable marsupial tympanic wing to the alisphenoid, but the os-bullæ is not free, it is merely an outgrowth of bone from the basisphenoid. The pituitary hole is present and in the large species the curious basi-cranial excavation; the optic foramina also and the sphenoidal side passages are remarkably developed. As in the genus *Phalangista* among the marsupials, and *Sorex* and *Talpa* among the British Insectivora, the antero-lateral vomers are evidently suppressed, or have a very temporary independent existence: the postero-lateral vomers are rather small, as in the hedgehog. In the embryo the main vomer is *relatively* as large as in the embryo whale, and is curiously cellular or spongy. In nestlings this one primary azygous centre has broken up into three: one, the largest, above, and two lesser below, sheathing it, as it sheaths, the base of the nasal septum. Now this multiplication of the vomers proper is thoroughly marsupial. It is unique, as far as I know, in the mode of its sub-division into secondary bony centres. In the African (Continental) family the elephant or jumping shrews (Macroscelidæ), as illustrated by the largest forms, *Petrodromus* and *Rhynchocyon*, we have a curious mixture of marsupial or metatherian and eutherian characters, so that they are aberrant as insectivores; the marsupial characters are most remarkable. These are: (1) the absence of an optic foramen in the embryo; (2) the alisphenoids scarcely overlapping the orbitosphenoids; (3) the tympanic wings of the alisphenoids are well marked, hollow shells in the embryo; (4) large antero-lateral vomers and postero-lateral vomers as large as in average marsupials, and, as in many of them, meeting and uniting at the mid-line; (5) a large distinct "os-bullæ," which makes a tympanic cavity as large as, and much like that of, *Petaurus* or *Phascolarctos*. On the high eutherian side we have, in the embryo, frontals as large as the parietals, and, strangest of all mammalian specialisation, a long *proboscis*, composed of thirty double rings of cartilage, a

structure quite similar to the proboscis of an elephant. The mesopterygoids are suppressed, but the pituitary hole is present.

I now come to a type for which no place can be found in our systems of zoology, but for which the late Prof. Peters, in despair, lodged with the Insectivora; I refer to the flying cat (*Galeopithecus*). This genus forms a family by itself, and yet has only two species; it should form an order, as the Hyrax does.

These two species of flying mammals are full of *remnants* of what is old, and *rudiments* of the *new*. I put them between the most archaic (marsupials) and some of the most curiously modified Eutheria, the frugivorous bats, and survey them from these two widely separate standpoints; but they possess that which neither phalanger nor bat will account for or explain.

With a flat, outspread, foliaceous skull, as completely ankylosed as that of any bird, and as thoroughly pneumatic in its post-orbital region, we have one of the largest and most perfect *hard palates;* with the upper incisors partly suppressed, the lower incisors well developed and utterly unique, and the premolars and molars strong for grinding. The cheek-bones and the squamosals are large and thoroughly marsupial, so are the small external pterygoid processes and internal pterygoid bones, and the very large mesopterygoids. I find no antero-lateral vomers, but Jacobson's organs and their protecting cartilages are *twice as long* as in any types yet examined, and the postero-lateral vomers are almost as well developed as in marsupials, whilst the main vomer is very large. The sphenoid bones are typically Eutherian, but the basisphenoid has beneath it, as in *lizards*, a small "parasphenoid"; this I find only in *G. philippensis*, and as yet in no other mammal. As in the marsupials, the jugal or malar helps to form the glenoid cavity, and the squamosal is as large as in *Cuscus*, the lowest of the *Eastern Marsupials*. The single flat tympanic bone, with its ossified and compressed meatus, is very remarkable; but this part of the skull corresponds neither with the marsupials nor the insectivores, and this is true also of several other of its characters.

Those things in which it agrees with the marsupials are not the same as in the hedgehog; it differs from both insectivores and marsupials in its own peculiar way, and in some things is more archaic than either. This type appears to me to be a waif from a large group of forms that were beginning to be transformed out of the metatheria into the flying eutheria (Chiroptera), certain of which, this living type among the rest, being arrested at the general level (or platform) of the Insectivora; they are equal to, rather than members of, the order Insectivora. The last type to be mentioned is the Tupaia, an Eastern form, rather high in position, yet combining characters for the first time seen in the Mammalia, namely, a perfect orbital ring, with old metatherian structures, such as the large os-bullæ, the small external and internal pterygoids, and a somewhat absorbed hard palate. The last three kinds, *Rhynchocyon*, *Galeopithecus*, and *Tupaia*, all show a curious mixture of that which looks upwards to the highest types, and of that which has been retained from the lower and more archaic forms of the mammalian class.

Anthropological Institute, February 10,—Francis Galton, F.R.S., President, in the chair.—The election of Douglas W. Freshfield, Lieut.-Col. J. Augustus Grant, C.B., F.R.S., and Cuthbert Edward Peek, M.A., was announced.—Mr. H. H. Johnston read a paper on the people of Eastern Equatorial Africa. The races treated of extend over a region of Eastern Africa lying between the 1st degree north of the equator and 5° to the south, and bounded on the west by the 34th degree of east longitude, and on the east by the Indian Ocean. The forest country on the hills or along the rivers is occupied by resident agriculturists almost exclusively belonging to the Bantu family, ethnologically and linguistically, and the forbidding wilderness in the plains is ranged over by tribes of either Galla or Masai origin, both of which may be roughly classed with the Ethiopic or Hamitic groups. The Wa-taita are of medium height, and have fairly good figures, but the men are somewhat effeminate and slight-looking. In facial aspect there is much variation: the teeth are filed and sharp-pointed, and the ears are so misshapen by prevailing fashion that it is hard to guess at their original shape. The body is disposed to be hairy, but is carefully depilated all over, even to the plucking out of eyebrows, eyelashes, beard and moustache. The hair is allowed to grow only on the occiput, and here it is much cultivated, and pulled out into long strings, which are stiffened with grease and threaded well with beads. There are but slight traces of religion among the Wa-taita. They are afraid of spirits who are supposed to dwell in large forest trees, and perhaps for the reason that their dead are always buried in the forest. Their marriages are arranged first by purchase, but after the preliminaries have been settled, the girl runs away and affects to hide. She is sought out by the bridegroom and three or four of his friends, and when found is seized and carried off to the hut of her future husband. The Akamba, who live to the north of Taita, are a very roving, colonising people, and great hunters. One of the most interesting tribes are the Wa-tarata, who exhibit marked peculiarities in their language and ideas. They are of fair height, some of the men attaining to six feet. They frequently let the beard and moustache grow, and usually abstain from plucking out eyelashes and eyebrows. Circumcision is general. Marriage is a matter of purchase, but no sign of imitating capture seems to be practised here. They number about two thousand, and bear an excellent reputation among the coast traders for honesty and friendliness. Mr. Johnston described some of the chief characteristics of several other tribes with which he had come into contact during his visit to Kilimanjaro, and referred particularly to the languages spoken by the various peoples, one of the most interesting of which is the Masai, which has many characteristics not possessed by most of the other African languages.

PARIS

Academy of Sciences, February 9.—M. Bouley, President, in the chair.—On a new disposition of the revolving mirror for the measurement of the velocity of light, by M. C. Wolf.—On the determination of the ohm by the amortisement method, by M. Mascart.—On the velocity of the detonation in solid and liquid explosive substances, by M. Berthelot.—On the epipodium of some of the gasteropods, by M. H. de Lacaze-Duthiers.—Note on the skeleton of an extinct hyæna (*Hyæna spelæa*) discovered by M. Felix Regnault in the Gargas Cave, near Montrejean, by M. A. Gaudry. This cave hyæna appears to have been scarcely larger than the present spotted species, but the bones were thicker, so that it appears to have been a heavier animal. The author proposes to constitute it a distinct species, as *Hyæna crocuta*.—Remarks on the new volume of the annual series issued by the Observatory of Rio de Janeiro, and presented to the Academy in the name of the Emperor of Brazil, by M. Faye.—On a new refrigerator prepared for the study of physico-chemical phenomena, by M. R. Pictet.—On the treatment of vines infested by phylloxera with the sulphuret of carbon, by M. P. de Lafitte.—Observations on Encke's comet made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan.—On some remarkable anomalies recently observed in the appearance of the planet Saturn, by Père Lamey.—Observations of the solar protuberances made at the Observatory of the Collegio Romano during the year 1884, by M. P. Tacchini.—Note on the solar parallax deduced from the daguerrotype plates taken by the French Commission for the Transit of Venus in 1874. A new method of calculation, comprising nearly all the observations recorded, by M. Obrecht. The parallax of the sun as determined on these data is expressed by the formula

$$\pi = 8''\cdot8 - 0\cdot004\,\delta L,$$

where δL is the correction in seconds of the time for the longitude adopted for the station of Pekin, L = 7h. 36m. 30s.—On a theory of curves aud surfaces admitting univocal correspondences, by M. S. Kantor.—On the equilibrium of a fluid mass to which a movement of rotation bas been communicated, by M. H. Poincaré.—On the variation in the electric resistance of bismuth placed in a magnetic field, by M. Hurion.—Temperature of solidification for nitrogen and the protoxide of carbon: relation between the temperature and pressure of liquid oxygen, by M. K. Olszewski.—On the solution of the carbonate of magnesia by carbonic acid, by M. R. Engel.—On the action of sulphur on red phosphorus, by M. F. Isambert.—On the crystals of monazite occurring in the diamantiferous gravels at Caravalles, Province of Bahia, Brazil, by M. H. Gorceix.—On the β-hexachloride of benzine, by M. J. Meunier.—On the sensitiveness of the eye to different degrees of luminosity in the ordinary light usually employed for reading, writing, &c., by M. Aug. Charpentier.—On the modifications produced in the chemical composition of certain secretions under the influence of Asiatic cholera, by M. A. Gabriel Pouchet.—On the physiological action of cocoine, third note, by M. Grasset.—On the physiological action of the sulphate of cinchonamine, by MM. G. Sée and Rochefontaine.—On the optical inactivity of

cellulose, and especially of that which is separated from the solution of cotton in the ammoni-cupric reaction, by M. A. Béchamp.—On the *Bacterioidomonas ondulans*, a new organism recently discovered in the intestine of the black rat, by M. J. Kunstler.—On the passage of pathogenetic microbes from the mother to the fœtus, by M. Kourassoff.—On the microbe of typhoid fever in the human system: its cultivation and inoculation, by M. Tayon.—Influence of light on vegetation and on the pathogenetic properties of *Bacillus anthracis*, by M. S. Arloing.—On the veinous circulation of the foot, by M. P. Bourceret.—On the nervous system of the embryos of the Limaceæ, and on the relations of the octocyst with this system, by M. S. Jourdain.—On the nervous system of the Teniæ, by M. J. Meiniec.—On the tetraptera *Tetraplatia volitans*, Busch., by M. C. Viguier.—On the spermato-genesis of the decapod crustaceans, by M. Arm. Sabatier.—On the existence of land mollusks furnished with lungs in the Permian formation of the Saône-et-Loire, by M. P. Fischer.—On a new method of transmitting the mildew of the vine, by M. Fréchou.—Remarks on the late earthquakes in the south of Spain, by M. Macpherson.

BERLIN

Physiological Society, January 16.—Dr. H. Virchow, referring to the results of his investigations into the structure of the eye in different mammalia, communicated those which had reference to the zonula zinnii. He illustrated by diagrams the situation of this organ and the course of its fibres, set forth the various methods of examination, the efficiency of which he demonstrated by a series of preparations, and discussed the different views advanced on the subject of the canal of Petit and the ciliary apparatus. As the result of his researches he found that the zonula zinnii consisted simply of fibres, which at places where they were ranged closer to one another were connected by an intermediary substance, while at those where the fibres kept further aloof from one another no such intermediary substance was present.—Prof. Albrecht from Brussels, as guest, spoke on the morphological significance of the swimming-bladder of fishes. As was known, this bladder was either in open communication with the intestinal tube, or the connection between the two was obliterated, and in this latter case it might well be assumed that the communication in question had existed in earlier stages of development. Many naturalists were of opinion that the swimming-bladder was homologous with the lungs, which likewise represented a tube in communication with the intestinal tube—an opinion, however, decidedly opposed to the views of the speaker. For in all fish the swimming-bladder was placed supra-intestinally, or on the dorsal side, while the lungs are invariably situated infra-intestinally, or on the ventral side of the intestinal canal. If these two organs were homologous, the dorsal organ, in order to its transformation into a ventral, must, by some means or other, have made its passage around the œsophagus. The assumption, however, of either a right-sided or a left-sided passage, or, in fine, of a double division of the swimming-bladder, each of which had wandered downwards on one side, there to form together the two halves of the lungs, was a notion which laboured under difficulties and contradictions. Altogether, in the opinion of Prof. Albrecht, it was erroneous in any case to explain dorsal and ventral organs as homologous, and just as much so in the intestinal canal as in the brain. The swimming-bladder and the lungs were, on the contrary, rather completely heterologous organs. The best argument for the truth of this view was afforded by those fishes which possessed two bladders, a supra-intestinal and an infra-intestinal. Such a phenomenon would be absolutely impossible if these bladders were homologous. In point of fact, in the gymnodonts, diodonts, as well as tetrodonts, there were found a dorsal swimming-bladder, and, beside it, ventral air-sacs proceeding from the œsophagus, by means of which these fish were enabled to inflate themselves. These ventral air-sacs were homologous with the ventral lungs and heterologous to the dorsal swimming-bladders. There were, furthermore, fishes which, of the two protrusions of the intestinal canal, developed only the ventral, while the dorsal became absorbed. Such was the case in Polypterus, which possessed an infra-intestinal swimming-bladder, and in which, therefore, the homologue of the lungs was alone developed. There were, moreover, fish in which both protrusions became absorbed—the dog-fish, for example, which had no swimming-bladder whatever. An interesting support to this view of Prof. Albrecht's was afforded by the fact that, even in the case of mammalia in which the ventral protrusion of the intestinal tube had developed into lungs, remains of the dorsal swimming-bladder were presented in a rudimentary form. Such the speaker took to be the diverticula of the œsophagus, a not uncommon pathologic occurrence in man, which were always dorsal and occupying a position opposite to the entrance into the larynx. These diverticula, according to the experience of surgeons, were not only innate. but also hereditary, a character which certainly witnessed to their phylogenetic significance. These dorsal diverticula of the œsophagus, which occurred only pathologically in man, were a regular occurrence in another mammal, the sow. In swine, therefore, among the mammalia, just as in diodonts and tetrodonts among fish, were found both protrusions of the intestinal tube, the supra-intestinal and the infra-intestinal, existing beside each other, the most indubitable proof of their heterology. Prof. Albrecht proposed calling the dorsal protrusion the swimming bladder, and the ventral the vocal bladder.—Dr. Kossel had from pancreas extract obtained a new base, which belonged to the group of bases obtained by him from the contents of animal and vegetable cells, guanidine, xanthine, and hypoxanthine. From an analysis of 75 kilogrammes of pancreas extract he had procured, besides guanidine and hypoxanthine, a hitherto unknown base, which he was able to separate from the two and obtain in fine crystals. With hydrochloric and sulphuric salts it likewise gave fine large crystals. By reason of its occurrence in the pancreas, Dr. Kossel had called this new base "adenine;" its chemical composition corresponded with the formula $C_5H_5N_5$: it was, therefore, polymeric with hydrogen cyanide, and held the same relation to hypoxanthine, $C_5H_4N_4O$, that guanidine, $C_5H_5N_5O$, did to xanthine, $C_5H_4N_4O_2$. Later on he succeeded in authenticating the presence of adenine in the spleen likewise, as also in yeast, so that this base, too, appeared to have a more general diffusion. Adenine appeared to have an important physiological significance, on account of its composition. It had hitherto been assumed that urea must be derived from a cyanic compound, though such had not been able to be traced in the bodily tissues. Adenine, therefore, in consideration of its constitution, would seem to have some relation to formation of urea, a conjecture which further investigations might settle.—Prof. Du Bois-Reymond laid before the Society monstrous hoofs of horses and bovine animals sent from the Falkland Islands to the Physiological Institute, which from their massiveness and the turning in of the horny material would, by their appearance, hardly be recognised for the hoofs of horses and bovine cattle.

CONTENTS

THURSDAY, FEBRUARY 26, 1885

THE RELATIVE EFFICIENCY OF WAR-SHIPS

THE *Times* of the 19th inst. contains a long and vigorous criticism by Sir E. J. Reed, M.P., of the ten largest British ships of war "launched in 1879, or since, or remaining on the stocks." These are the *Ajax*, *Agamemnon*, *Colossus*, *Edinburgh*, and the six vessels which constitute the *Admiral* class. These vessels are all built upon the central citadel system—*i.e.* their armoured portions are merely citadels erected in the middle of the length; the ends being left without armour-plating. One of these ships may thus be considered as being divided into three parts, so far as her out-of-water structure is concerned. The central part is plated completely around with very thick armour, which extends from the upper deck to several feet below the water-line; while the parts before and abaft this are not protected by armour, but rest upon a thickly plated deck situated at the depth of the lower edge of the citadel armour. This deck protects the hull beneath the armour against the effects of a plunging fire.

This system of construction was advocated by Sir E. J. Reed before the Committee of Naval Designs in 1871. It was first adopted in the *Inflexible;* and immediately gave rise to a discussion respecting the size of the armoured citadel which Sir E. J. Reed has, with persistent energy, kept up ever since. The *Times'* letter above referred to is a continuation of the old, and well-remembered, *Inflexible* debate. A statement of the points then in dispute will be found in NATURE of July 12 and 19, 1877. Sir E. J. Reed maintained that the fighting power of the *Inflexible* was gravely compromised by the shortness of her armoured citadel—which was not long enough to make the ship stable in the event of her thinly plated ends being so much injured as to lose all power of excluding water. A committee was appointed to inquire into and report upon the matter, but Sir E. J. Reed refused to give evidence before it.

Sir E. J. Reed now says, with reference to the later ships of this type: "I have to state, and am prepared to demonstrate to any competent tribunal, that there is not one of these ten ships, the latest added to the British Navy, that cannot be either capsized and sunk, or sunk without capsizing, without any shot or shell whatever being directed against those parts of the ship which are armoured. . . . The French armoured ships . . . must in all reason be expected to dispose of these English ships in a very few minutes by simply destroying their unarmoured parts. . . . I will here repeat in the most public and responsible manner that the *Ajax*, *Agamemnon*, *Colossus*, and *Edinburgh*, and the six ships of the *Admiral* class, are all utterly unfit to engage the corresponding French ships; unfit to enter the line-of-battle at all; and unfit to be retained on the list of armoured ships."

This is strong language, but not so strong as that which is used respecting the members of the Board of Admiralty and the Constructors of the Navy. Sir E. J. Reed blames Admiral Sir Cooper Key, the First Sea Lord of the Admiralty, for not setting his face against "the prospect of British ship after ship capsizing in battle, before their armour had been violated or touched." He fears that the day may be near "when the present betrayal of our Navy by a set of politicians, admirals, and constructors may wring from us a cry which the very ends of the earth will hear." The Admiralty of the day is "foolish enough, cruel, heedless, reckless, and faithless enough" to rely upon the skill and vigilance of the seamen "whom they send unprotected to destruction"; and "to substitute them for those actual physical defences which the ship herself should embody." Sir E. J. Reed is "fast coming to feel something very like contempt" for the heads of the Admiralty; and he considers that "they are unequal to the work they have undertaken, and have become a source of grave national danger. . . . Upon the heads of the present Board of Admiralty must continue to rest, after this public warning, the responsibility of delivering ten British ships of the largest class an easy and certain prey to destruction should war arise."

These are grave charges; and if the questions involved by them could be settled by forcible or scornful language, there would be little remaining to be said. It is desirable, however, to disregard as much as possible the rhetorical effect of the statements made, and to endeavour to ascertain what are the simple facts of the case. It is important likewise to remember that the comparison instituted between our ships and those of the French is not one between fully armoured and partially armoured ships, but between partially armoured ships on both sides. The armour protection is very limited in the French ships, but it is differently distributed from what it is in ours. The armour of the French ships stops at a very small height above the water-line: and the space between the top of the armour and the upper deck may be destroyed as easily as the unarmoured ends of our ships. Any approach to destruction would completely cripple the fighting power, speed, and manœuvring qualities of these ships.

If the assumptions upon which Sir E. J. Reed's main argument is based are sound and indisputable, then no condemnation of the Board of Admiralty and of the Naval Constructors could be too strong or unqualified. We are disposed to go a long way with him in believing that all is not so well as might be wished with our recent ships, and that there is incompetency and something very like indifference to be found in high quarters at the Admiralty: but, before adopting, in all their breadth and fullness, the views so vigorously and ably advocated by Sir E. J. Reed, there are one or two points upon which we feel that more light is needed. Indeed, we are convinced that the present widely discordant views that are held by the different parties to this naval discussion are impossible of reconciliation until the points referred to are cleared up.

The chief one of all is, Can the thinly-plated ends of these citadel ships be readily destroyed in action and made useless—or worse than useless—for the purpose of contributing buoyancy or stability to the ship? If they can, it is obvious that the ship's safety may be speedily endangered without the thick armour plating of the citadel being penetrated. Sir E. J. Reed assumes that this is unquestionably the case, and he emphatically asserts that our ten most powerful ships of recent construction might

be disposed of "in a very few minutes by simply destroying their unarmoured parts." It is upon this assumption that his charges against our ships and their constructors are mainly based. If it be correct, the Admiralty stand convicted of culpable neglect or error; but if it be incorrect, or very doubtful, then Sir E. J. Reed's charges are pointless and unjustifiable.

The question is one of most vital importance to the fighting efficiency of our principal ships of war; but how is it to be settled? It is not one with which mere theory or abstract science can deal: actual experiment can alone answer it. Sir E. J. Reed believes, and asserts, that such structures as the thinly-plated ends of our recent ironclads may be effectually destroyed in a few minutes, and that single shells may shatter large portions of them into fragments. He says:—"It is not a mere question of riddling the ends, but also one of blowing them up by shell fire: and how effectually they may be thus destroyed was shown at Alexandria, where a single shell, bursting against the unarmoured part of the *Superb's* side, tore a hole in it 10 feet by 4 feet in extent."

The apologists for this system of construction say, on the other hand, that if the area is increased over which the armour is spread, as would be the case if the citadels were lengthened, the thickness of armour throughout would require to be reduced; and the armour protection would therefore be less in the central portion of the ship which incloses the boilers, engines, and other essential elements of fighting efficiency. Many naval artillerists say, further, that unless the ends can be plated with the very thickest of armour, it is better to include everything which contributes to fighting power within the armoured citadel or below the armoured deck, and to make the ends as thin as possible. They argue that shells which meet with considerable resistance in penetrating armour of moderate thickness will shatter the ship's side, and make holes which cannot be stopped; whereas they almost invariably make clean holes through thin plating, and would, in the vast majority of cases, pass through the ship and out upon the other side. Such an instance as Sir E. J. Reed calls attention to in the case of the *Superb* would not, it is said, occur in practice more than once in one hundred times. The clean holes made by shells in thin plating can be stopped effectually and quickly by men stationed inside with shot-hole stoppers. These are made of india-rubber, and open and close like an umbrella. They are pushed out from the inside, and then pulled back and opened over the outside of the hole. The buoyancy and stability afforded by the ends can, it is confidently stated, be preserved by these means; whereas the damage done to any but the very thickest of armour plating would be so much greater that the holes made by shells could not be so effectually dealt with.

It is also pointed out that it is extremely difficult to strike a ship exactly at her water-line. The great majority of projectiles strike at some distance above it. If they are aimed too low they ricochet from the water surface and strike the ship above the water-line. It is most difficult to penetrate a ship exactly at her water-line; and if she is so penetrated, the holes may be much more readily and effectually stopped when the plating is thin than when it is thick. This is the argument which forms the answer to Sir E. J. Reed's charges.

Sir E. J. Reed says that "the reply to the British ships which are being made to depend for their flotation and stability upon their unarmoured ends will inevitably be small-gun attack," and he considers that even the fire from machine-guns may be sufficient to cripple them. This opens up a complicated question and one which cannot be fully considered in all its details from a merely abstract point of view. There is obviously, however, a limit to the effective use of small gun and machine-gun fire, which is imposed by the necessity of protecting them by armour if they are to fight at short range. If the guns are not protected by armour they can only be relied upon at long ranges; and even then they may as readily be placed *hors de combat* by the fire from the enemy as succeed in penetrating, still less in destroying, the unarmoured ends of the latter.

These are points which experience alone can throw any clear and definite light upon. Each party may continue to advocate its own view with great show of reason, but neither will convince the other till the effect of artillery fire upon such structures as the unarmoured ends of the ships in question has been thoroughly tested. In the meantime the public mind is only being bewildered and wearied by the reiterated discussions of questions which cannot be settled by mere argument or force of words.

A structure similar to the unarmoured ends of one of our ships might easily be built and placed afloat. It should then be fired at from various distances with guns of different sizes. Valuable data might then be obtained upon two crucial points: (1) the percentage of shots which would strike sufficiently near the water-line to affect prejudicially the buoyancy or stability; and (2) the nature of the holes that would be made; whether such as are capable of being easily stopped from the inside, or such as admit of no effectual stoppage, but practically constitute a disintegration or destruction of the fabric. This simple experiment might surely be made in such a way as to set at rest the discussion that has now been going on for so many years respecting the efficiency of the system upon which the safety and fighting power of our most powerful ships depends. Still, "water conditions" would be the most favourable for such experiments; because it would obviously be more difficult to make good practice at a vessel's water-line in action—under the ordinary circumstances, at sea, of rolling motion and the relative movements of the vessels engaged—than at a quiet and carefully arranged trial.

The only logical and effective answer that can be made to Sir E. J. Reed's letter is that which would be furnished by the results of experiments such as we have indicated; and that answer cannot be made too soon, or too complete, either for the reputation of the Admiralty and of the Constructors of the Navy—who, to say the least, appear to be greatly in the dark respecting the practical merits of the system to which they are committed—or for the satisfaction of the public mind.

This question, upon the merits of which Sir E. J. Reed's charges must either stand or fall, is one which only Science can settle by experimental tests; but there is an important point underlying another assumption contained in his letter which may be discussed with advantage from a more abstract point of view. He says: "The Admiralty Director of Naval Construction, in the article 'Navy,' in the 'Encyclo-

pædia Britannica,' lays down the following principle :—'The fairest available approximate measure of the power of the ships is their displacement or total weight. It always represents power of some kind.'" Sir E. J. Reed adopts this principle, without reserve or qualification, and employs it as an empirical method of determining the relative fighting powers of the ships of our own and the French navies.

"Bearing this principle in mind, as one accepted and avowed by the Admiralty" he proceeds to compare the displacements of ten of the largest French ships recently built with ten of the corresponding ships of our own navy. The following result is arrived at :—"Looking at these figures, and bearing in mind the doctrine quoted—that superior displacement means superior power, and inferior displacement inferior power—we here see that the English ships have been deliberately made inferior by our Admiralty, ship by ship and squadron by squadron."

We do not know what authority there is for saying that this "principle" is accepted and avowed by the Admiralty. True, it is propounded by Mr. Barnaby, the Director of Naval Construction, in the latest edition of the "Encyclopædia Britannica"; but we have not heard that the Admiralty accept and avow it. We hope, for the sake of the scientific reputation of the Naval Department, that they hold no such fallacious and absurd doctrine. It is surprising to find a scientific man of Sir E. J. Reed's eminence and ability assenting to, and adopting, Mr. Barnaby's so-called "principle." What is stranger than all, however, is that Sir E. J. Reed should not see that the adoption of it is inconsistent with his main contention that our ten newest armour-clads are practically worthless, for quite other reasons, as compared with those of the French, and could be disposed of by the latter "in a very few minutes."

The average displacement of the ten English ships referred to by Sir E. J. Reed is 9,363 tons, and that of the corresponding ten French ships is 10,470 tons. Applying Mr. Barnaby's principle in the sense in which it is used by Sir E. J. Reed—bearing in mind that "superior displacement means superior power, and inferior displacement inferior power," and that "the fairest available approximate measure of power" is "displacement or total weight"—we arrive at the conclusion that the fighting power of the ten English ships is rather less than nine-tenths that of the French ships. Had their displacements been greater they would, upon the same principle, have been more powerful than the French ships. But Sir E. J. Reed believes that, apart from displacement altogether, and because of the different systems of construction employed in the two cases, the English ships could be sunk by the French ships in a very few minutes. The assumptions upon which the respective arguments are based are obviously inconsistent with each other. One is that the English ships are inferior to those of the French because their displacements are less; the other is that they are inferior because the details of their construction are not so wisely and efficiently designed. Either one or both assumptions may be correct; but the one has no necessary relation to the other.

But we will compare Mr. Barnaby's present principle with an empirical formula previously laid down by him for determining the comparative efficiency of ships of war. In the course of a lecture delivered in the Royal United Service Institution, in 1872, upon "Modern Ships of War," Mr. Barnaby put forward the following formula :—

$$\frac{A \times G \times H \times S^3}{L \times 100} = \text{comparative efficiency},$$

where A is the weight of armour per ton of ship's measurement, G the weight of protected guns and ammunition, H the height of battery port-sills above load water-line, S the speed in knots at the measured mile, and L the length of the ship.

Mr. Barnaby applied this formula to the seven ironclads named in the table given below. In this table we have placed, alongside the names of the vessels, a column which contains their displacements in tons. The next column contains their comparative efficiencies, as computed by the above formula; and the last column contains their comparative efficiencies, upon Mr. Barnaby's new principle that displacement is a fair measure of power. It will be seen that, according to the latter, the most powerful of these seven ships is the *Minotaur*, and the next the *Warrior*. The relative efficiency of the former vessel is three times greater than that given by Mr. Barnaby's previous formula; and the latter is nearly four times greater. The *Warrior* and the *Minotaur* are, according to this standard of comparison, the most powerful of the seven ships named; while the *Minotaur* would, upon the same principle, be classed as the most powerful fighting ship the British navy possesses at the present time—with the single exception of the *Inflexible*. In reality, however, the *Warrior* and *Minotaur* are the weakest and least efficient ironclads we possess; and are invariably classed as obsolete even in the most favourable estimates that are made of the fighting power of the British navy.

Names of ships	Displacement in tons	Relative efficiencies as computed by Mr. Barnaby's formula, $\frac{A \times G \times H \times S^3}{L \times 100}$	Relative efficiencies upon principle that power varies with displacement
Monarch	8,320	149·8	149·8
Hercules	8,680	113·4	156·2
Captain	7,900	83·3	142·2
Vanguard	6,010	83·0	108·2
Minotaur	10,690	61·1	192·4
Warrior	9,210	44·5	165·8
Defence	6,150	10·9	110·7

Nothing further can be necessary to show the fallacy, and the absolute inconsistency, of the views put forward at various times by Mr. Barnaby, respecting the standard by which the fighting power of a ship, or of a navy, may be judged. He has given no justification of either of the methods described; nor attempted to show that they are approximately reliable. The formula laid down by him in 1872 recognises that the fighting power of a ship of war is made up of various distinct and independent elements—that the amount of armoured protection, as represented by weight of armour; the power of the armament, as measured by its weight; the speed, and other qualities constitute elements of fighting power, which have different relative values, and which must be separately taken into account. We here find the value of manœuvring power, or handiness in turning, recognised by introducing the length of the ship as a divisor into the formula. This element of fighting power is assumed to

vary inversely as the length; so that, in similar ships, it would vary inversely as their displacements. In other words, so far as one element of fighting power is concerned, and that a very important one, the measure of its amount is not the displacement, as Mr. Barnaby now assumes, but the inverse ratio of the displacement.

The fighting power of a ship is thus composed of several diverse and independent elements; and there is nothing approaching to a consensus of professional opinion as to the relative importance of these elements. To assume that they all vary together with the ship's dimensions, or with her weight in tons, is in the highest degree delusive and absurd. The displacement of a ship measures her weight and nothing more. Whether that weight has been effectively and wisely employed in developing a high degree of fighting power, is an entirely independent matter; and one upon which the whole question of fighting efficiency depends. The statement that displacement "always represents power of some kind," merely begs the question. Of course it represents power; but such power is simply that of displacing water. It may represent that and nothing more, or it may represent in addition the possession of great fighting power, or of other desirable qualities. But the possession of such qualities, and the degree in which they will be developed, must depend entirely upon the skill of the designer—an arbitrary personal factor which is not always limited by the cubic feet of displaced volume that are placed at his disposal. Mr. Barnaby himself pointed out in the paper above referred to, that although the *Defence* and *Vanguard* have approximately equal displacements, the latter carried one-half more armour-plating than the former upon three-fourths of the weight of hull; and was so superior in manœuvring capability that she would turn completely around in four and a half minutes, whereas the former vessel required seven minutes to complete a circle. This difference in qualities, and superiority in fighting power, of the *Vanguard* over the *Defence* is absolutely undiscoverable by merely comparing the displacements.

All the comparisons we have seen of the fighting powers of modern ships of war and of our own and foreign navies, have been more or less vitiated by the arbitrary standards that have been selected as the basis of such comparisons. The displacement basis is unreliable and misleading, and furnishes no test whatever of fighting power. It would be extremely difficult to devise any simple standard by which the popular mind may be fairly impressed with the relative powers of our own and foreign navies; while for purposes of exact comparison or of technical discussion no such standard could be regarded as absolute. Before a simple standard or unit of comparison can be framed, which will be satisfactory or useful, naval officers, artillerists, and constructors require to agree among themselves about the relative importance of the various elements that make up the fighting power of a ship. The defensive values of armour-plating, speed, turning-power, and other protective qualities, and also the offensive values of the gun and torpedo armaments, the ram, speed, &c., require to be separately evaluated and their relative importance determined. If a general agreement could be arrived at as to the relative approximate values of each of these independent elements of offensive and defensive power, an empirical formula might be framed —such as Mr. Barnaby attempted with insufficient data in 1872—which would fairly represent the gross fighting efficiency of a ship. Till this is done, no rule can possibly be devised which will indicate anything more than the mere opinions of the person who frames it; while often, as in the case of Mr. Barnaby's present displacement basis, the application of the rule may be misleading in a degree which its framer could never have foreseen or intended.

Sir E. J. Reed's letter to the *Times*, and the whole force of the charges contained in it, rests mainly upon the truth of the two assumptions we have considered. The first is that the unarmoured ends of our present ironclads have practically no protective value. This is a point which, as we have said, may be determined once and for all by scientific experiments. The second assumption is that the comparative efficiency of our own ships and those of foreign powers may be approximately measured by merely comparing their displacements. This proposition is unsound, and does not admit of any qualifying corrections short of depriving it of all specific meaning. A scientific standard or unit of comparison which may be fairly applied to the approximate determination of the relative fighting powers of war-ships and navies is greatly to be desired; but before such an one can be framed, the persons who have to use our ships of war and to take them into action, and those who are responsible for their efficient construction, must come to some definite understanding as to what the various elements of fighting power consist of, and what are their relative degrees of importance; and to do so they must call in the aid of Science.

PROFESSOR WILLIAMSON'S DYNAMICS

An Elementary Treatise on Dynamics, containing Applications to Thermodynamics, &c. By Benjamin Williamson, F.R.S., and Francis A. Tarleton, LL.D. (London: Longmans, Green, and Co., 1885.)

PROFESSOR WILLIAMSON is already so well known to the student by his excellent text-books of the Differential, and of the Integral, Calculus, that his appearance in a new field of authorship is sure to excite attention. We accordingly opened the present work with expectations of a very high order. Not, of course, expectations that much novelty of matter could be introduced in an elementary work on a subject which has been thoroughly threshed-out, but that possibly fresh interest and easier assimilability might be given to long-known facts and processes by some novel mode of presentation.

In these expectations we have been disappointed. Either the subject of Dynamics does not admit of treatment superior to that which it has already received, or our authors are not destined to be the pioneers to the possible improvements. Our special reasons for this statement we will give with some detail, but we may begin with some general observations.

From the time in which Jackson, Lloyd, Whewell, and many others, introduced continental methods to the average Honour-man; through the period of Earnshaw, Pratt, Wilson, Tait and Steele, Griffin, Walton, &c., to the Parkinson, Bezant, Routh, &c., of the present day, there has been a plethora of treatises in English on the various parts of elementary Dynamics. Some of these

were robust, and showed considerable vitality, others sickly and short-lived. But, bad or good, among them they have practically exhausted the resources of the subject, so far as the theorems presentable to a beginner are concerned. The only ringing of the changes has been in arrangement, modes of presentation, and proofs.

But from the books of the future, some of which, at least, we may expect to see starting into existence in the present, we naturally, though perhaps vainly, look for something higher and better than this. We now have elementary treatises on the various branches of mathematics required in Dynamics (two, in fact, due to Prof. Williamson himself) so much superior to any that existed even twenty years ago, that we no longer require to have intricate steps of ordinary differentiation or integration introduced into a text-book of that subject. What we require may be summed up in two words, *Foundation* and *Arrangement*. To these must, of course, be added, as a requirement in every scientific treatise, *Consistency*.

The foundations of the subject, in by far the best form in which they have yet been presented, were given by Newton. He expressly states, before proceeding to give his second interpretation of the Third Law of Motion, that (so far) he had been giving principles generally accepted among mathematicians. But we can barely imagine the effort which must have been made by that transcendent genius in extracting such simple and yet all-comprehending statements from the portentous verbiage of even the most able of his precursors. Step by step, in Britain, Newton's system was forsaken; one of his Laws was split up into fragments, another ignored and its place supplied by gratuitous additional Axioms; till at last the monstrous process culminated in the adoption of Duchayla's so-called statical *Proof* of the Parallelogram of Forces. Thus everything was ripe for Thomson and Tait's reintroduction of the grandly simple system of Newton. The results of this step have been alike remarkable and important. These authors also introduced, after the example of Ampère,[1] the notion of separating the science of motion in the abstract (*Kinematics*) from that of motion of matter:—thus lightening the student's work, in Dynamics proper, to at least as great an extent as it is lightened by his previous study of integration and differential equations.

Now, in the book before us, these improvements on the text-books of twenty years ago are only partially adopted. Kinematics is not made a strictly preliminary study, but inserted in detached fragments. The exploded "statical measure" of force haunts us all through the book, sometimes leading to extraordinary results. Thus, opening at p. 30, we find the following passages, in which we have italicised a few words:—

"Acceleration varies as Pressure."

"This equation enables us to determine the velocity generated . . . by a constant force . . . whenever the *pressure* which measures the *force* is known, and also the *weight* of the body."

"Thus a force which is capable of supporting a weight of 112 lbs. is called a force of 112 lbs."

". . . the same *effort* which would project a small stone to a considerable distance will move a large one but slightly."

[1] Ampère has never, to our knowledge, received the credit due to him for much of his best dynamical work:—*e.g.* the u, θ equation of central orbits.

Here we see, at a glance, the effects of want of system Pressure, Force, and Effort are used as completely synonymous and interchangeable terms. Now the first term has a perfectly definite meaning in science (introduced without definition or warning by our authors in § 290 of the book, to the utter bewilderment of the reader fresh from p. 30), and it means something differing from force in exactly the same way as a linear inch differs from a cubic inch. As to the Effort exerted in throwing a stone, we imagine that, if employed at all in scientific language, it would signify properly the work done, not the force applied; the two things differing as a square foot does from a linear foot. Of course our authors do not require to be told this, but why muddle the student by giving him slipshod information which he must *unlearn*, if he is ever to make progress?

On the opposite page (31) we find:—

"If a uniform pressure [force] of 3 lbs. [weight] produce a velocity [speed] of 10 feet [per second] in the first second, find the weight [mass] of the body acted on."

The insertions are ours, made with the view of showing how the question ought to be stated unless there is to be complete confusion of nomenclature.

Since Clerk-Maxwell published his admirable little book on "*Matter and Motion*" there has been left no excuse whatever for a misuse of the word *Velocity*. The adoption of Hamilton's Vector ideas effected an immense improvement in all these elementary matters. Yet we not only find constantly, in the book before us, this confusion of speed and velocity, but something even more grave, of which one example appears in the above extract. This is the use of the word "velocity" in the sense of so many units of length. See, for instance, pp. 28, 29:—

"'In what time will a falling body acquire a velocity of 400 feet?'

"'If one minute be taken as the unit of time, what should be taken as the value of g?'

'*Ans.* The velocity per minute acquired in one minute by a falling body.'"

Now, what on earth is a "velocity of 400 feet" or a "velocity per minute"? To make the first statement intelligible we must add "per (specified unit of time)"; and for "velocity," in the second statement, we must read "velocity in feet"; or, preferably, "speed in feet." The "per unit of time" is already present on *this* occasion.

Under this category we must quote the truly sensational heading of § 19:—

"Relation between Velocity and Space,"

for this is also obviously based upon the above erroneous designation of "velocity" as so many units of length.

In p. 124 we find:—

". . . time becomes a necessary element when we come to compare the *efficiency* of different agents. For instance, if one agent . . . performs an amount of work in one hour which it requires another five hours to accomplish, the former is said to be five times as efficient." [The italics are in the text.]

But, turn to p. 438, and we read:—a heat-engine being now the "agent":—

". . . the ratio of the heat converted into work to the heat drawn from the source is called the *efficiency of the engine*." [Again, the italics are in the text.]

It appears from this, as from a former example, that it is necessary to take the same word in two perfectly different meanings according as it is met with in the first (or ordinary dynamical) part of the book, and in the later (or thermodynamical) part. Such at least is the case with the two specially important terms, *Pressure* and *Efficiency*.

It is perhaps hypercritical to call attention to peculiarities of expression which, however they may puzzle him, can scarcely mislead the student. Else we might ask why (p. 8) a point is "*animated* by any number of velocities," or "*subjected* to any number of simultaneous velocities," or why "additional velocity" is said in contrast (p. 12) to be "*received*."

We have marked at least a score of places, in addition to those already noticed, in which the same or similar confusion occurs:—and yet we have *read* in all only about a fourth of the book here and there, having glanced over the rest much more hastily. But it is enough to have said, while illustrating our remarks by simple instances, that this is certainly not a book for beginners, nor for any one whose hold of the exact meaning of scientific terms is precarious:—though it may be consulted without danger (scarcely, we should think, with actual pleasure) by a student who, already soundly educated in the *principles* of Dynamics, desires to get a rapid and condensed *résumé* of their development by mathematical methods.

The principle of dual authorship rarely works well in practice. One of the authors of this book invariably speaks of *Centre of mass* (or of *inertia*) of a body, the other as invariably of *Centre of gravity*. And their responsibility has been so thoroughly divided, that *neither* of these terms is defined, so far as we can find (even with the help of the Index), anywhere in the volume. Again, one of the authors seems to have been always on the look-out to put in a little bit of Kinematics wherever he had a chance. And surely a third must have been at work, whose function was to stick in some sections on the *Rotation of a Rigid Body* (p. 92) between the sections on *Circular Orbits* and those on the *Simple Pendulum*.

The extraordinary *Olla podrida* of Schell is one of the authorities mentioned in the *Preface* as having been largely borrowed from. The book would certainly have been very much better had that work been let alone; though no work more richly deserves to be plundered in its turn than does that of Schell, who simply adopts (and too frequently distorts) whatever pleases him.

OUR BOOK SHELF

Les Organismes problématiques des Anciennes Mers. By the Marquis de Saporta. (Paris: Masson, 1884.)

THE views expressed in Saporta and Marion's "Evolution des Cryptogames" (reviewed at length in NATURE, vol. xxiv. pp. 73, 558) as to the origin of certain markings commonly met with in palæozoic rocks, has led to a long discussion in which many have taken part, the chief champions on either side being Dr. Nathorst, the distinguished Swedish botanist, and the Marquis de Saporta. Dr. Nathorst maintains that they are tracks left by moving or burrowing animals or other inorganic markings, whilst Saporta holds to his original opinion that very many of them are casts of primæval *algæ*, of kinds now extinct. Nearly all of these markings are in bas-relief on the under surfaces of slabs as if they were moulds of prints or impressions traced in the ancient muds, thus at first sight greatly favouring Nathorst's view of their origin. Saporta demonstrates on the other hand that this is a by no means uncommon mode of fossilisation among undoubted plants, and when we reflect on the composition of algæ, we shall see that scarcely any other mode of fossilisation among them is possible. A leathery olive green sea-weed lying on an oozy mud would cause an indentation, and if subsequently covered up, would keep the old surface from contact with the fresh mud, until it might, under favourable conditions, have become sufficiently hardened to retain the impression. The sea-weed, as most olive weeds do now, if left in water or fresh mud, would eventually completely dissolve away, leaving no perceptible organic trace of its presence. The cavity thus left would be filled in at last by the overlying mud, and only a cleavage plane would remain, following the contour of the under side of the weed, and marking its former presence. Sometimes, though rarely, the sea-weed might not decay until a cleavage plane had been established around its entire circumference, without leaving the smallest trace of its internal structure, as we often find is the case with far more resisting cryptogamic stems in the older rocks. This Saporta finds is the case with the Bilobites, one of the most vexed of all the "Organismes problématiques," and he relies with good reason upon their occasional occurrence in this condition and on their reticulated structure to support his contention that they cannot be mere worm tracks or burrows, and that in point of fact they can be naught but the impressions of primordial algæ. J. S. G.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Civilisation and Eyesight

MY attention has only recently been called to a communication from Lord Rayleigh, which appears in NATURE for the 12th inst. (p. 340), and on which I crave permission to make a few observations. Lord Rayleigh questions whether the eyes of savages, "merely as optical instruments," are greatly superior to our own; and suggests that any superiority which savages possess may depend upon "attention and practice in the interpretation of minute indications." He explains that "the resolving power of an optical instrument is limited by its aperture," and then proceeds as follows:—

"With a given aperture no perfection of execution will carry the power to resolve double stars, or stripes alternately dark and bright, beyond a certain point, calculable by the laws of optics from the wave-length of light. With sufficient approximation we may say that a double star cannot be fairly resolved unless its components subtend an angle exceeding that subtended by the wave-length of light at a distance equal to the aperture. If we take the aperture of the eye as one-fifth of an inch, and the wave-length of light as 1-40,000th of an inch, this angle is found to be about two minutes; and we are forced to the conclusion that there is no room for the eye of the savage to be much superior in resolving power to those of civilised physicists, whose powers approach at no great distance the theoretical limit as determined by the aperture."

I understand this to mean that optical conditions limit the resolving power of the eye to objects which subtend a visual angle of about two minutes, and that civilised physicists approach this theoretical limit at no great distance.

With great submission to the high authority of Lord Rayleigh, I venture to question whether we have any data from which to draw conclusions with regard to the possible optical powers of the eyes of the human race. We should probably fall into grave error if we were to argue from the reduced eye of Listing,

or even from the eyes of the small number of persons whose visual function has been minutely tested, to the properties, as optical instruments, of the eyes of mankind in general. "La position," writes Helmholtz, "des foyers, des points principaux et des points nodaux de l'œil est assurément soumise à des variations individuelles assez importantes, puisque la plupart des mensurations de l'œil et de ses diverses surfaces réfringentes présentent, chez différents sujets, des différences plus grandes qu'on ne paraissait devoir les attendre pour un organe dont les fonctions semblent réclamer une si grande exactitude de construction."

As a matter of fact, the theoretical limit of resolving power assigned by Lord Rayleigh, to which he tells us that civilised physicists "approach," is one which civilised physicists have considerably exceeded. The mean of twelve observers, as quoted by Helmholtz, gives resolving power under a visual angle of 101 seconds; and this mean is reduced by two cases in which the angles were 124 and 147 seconds respectively. The minimum was 51 seconds, the most frequent angle was about 80 or 90 seconds. The commonly accepted standard of normal vision among civilised people is satisfied by deciphering letters the parts of which subtend visual angles of one minute, while each letter as a whole subtends a visual angle of five minutes.

I cannot say, however, that I think any such tests are very material to the issue. The eyes of civilised physicists, or of such of them as have undertaken practical research in physiological optics, are probably very highly cultivated, and I doubt whether resolving power, which must greatly depend upon the functional activity of the central depression of the retina or, in the case of stars, upon the functional activity of the zone which immediately surrounds the yellow spot, furnishes any accurate test of acuteness of vision in the sense in which I employed the phrase.

Assuming the civilised man and the savage to have eyes of precisely equal optical value, the latter might yet possess an acuteness of vision greatly in excess of that of the former; and this excess might be due to conditions of the percipient elements of the retina which, in the case of the savage, permitted the optical powers to be utilised to the fullest extent. The savage might have greater sensitiveness to variations of light, greater sensitiveness to colour, and acuteness of vision over a larger retinal area. All these advantages might be conferred by better formation or higher development of the retina, and such higher development might at once be promoted by exercise and handed down by descent. I support the "commonly-received view" that the vision of savages is more acute than that of civilised men, because this view seems to me to be established by abundant testimony, and to be in perfect harmony with physiological knowledge. I feel very strongly that the conditions of town life are unfavourable to the evolution of the eye and favourable to its involution or degradation; and I believe that a moderate amount of attention might greatly modify these conditions, and might do for the eyes what is done by athletic games and exercises for the muscles.

With regard to the improvement of Lord Rayleigh's own vision, in a dim light only, by concave glasses, I think his Lordship cannot fail to see that the case, as stated, does not contain all the data which would be required in order to arrive at an explanation of the phenomenon.

R. BRUDENELL CARTER

IN a short article on Civilisation and Eyesight which appeared in NATURE of February 12, Lord Rayleigh expresses the belief that the greater visual acuity of savages "is a question of attention and practice in the interpretation of minute indications" and is not ascribable to any possible inherent superiority in their eyes, regarded simply as optical instruments. With this conclusion probably most who have had opportunities of testing the sight of uncivilised races or read the account given by those who have undertaken such examinations, will agree. The same difference in making more or less out of an imperfect retinal image is met with in different individuals with the same degree of short sight, and otherwise subjected to similar conditions according as they have or have not been in the habit of resorting to constant optical correction of their defect. Such a cerebral elaboration of the retinal image, as it might be called, constitutes also probably the main reason for the difference between the visual acuity of children who have only just learnt to read the letters of the alphabet and adults, which our ordinary tests so frequently show.

The question of the increasing prevalence of short sight has for a considerable time been the subject of much investigation and speculation in Germany, the results of which have been in many cases to give rise to predictions of rather an alarmist tendency. These, again, have led to legislation in the shape of regulations with respect to school appliances which might meet the theoretical requirements of the most energetic and influential agitators. It is to be hoped that, as the question is now being brought forward in this country, it will be viewed in a more comprehensive manner. The numerous statistics from German schools have shown that the proportion of short-sighted boys continually increases from form to form, and from this fact it is very generally argued that the continued use of the eyes for the perception of near objects is the essential if not the only factor in the production of short sight. This view appears, again, to be supported by statistics which allot the largest proportion of short-sighted individuals to those branches of industry or those pursuits which constantly call for near vision. Two points, however, appear to be forgotten, or at all events fail to receive sufficient consideration, in arriving at such a conclusion. In the first place, there is an undoubted tendency to increase in the degree of short sight with age alone up to the period of cessation of growth. This has been shown to be due to the elongation of the antero-posterior axis of the eye, which carries the retina further and further from the principal focus of the dioptric media, and is in the vast majority of cases no more a disease than is the attainment of a greater than average height by a certain number of individuals. It is merely a type, and as such is governed by the laws of heredity. A small proportion of cases of short sight are, however, due to disease. These differ from the ordinary cases in that they are seldom hereditary and are not more frequently present in the learned than in the absolutely illiterate classes, besides which the pathological changes to which they are due can often be detected with the ophthalmoscope. The second point which has to be taken into consideration is how far the greater proportion of short sight amongst literary men, or artisans whose daily work necessitates close vision, is actually due to their occupation, or depends on the circumstance that, being originally short-sighted, they have drifted into pursuits which are more attractive to them, owing to their not being able to enjoy out-door work or sports to the same extent as others whose eyes are more fortunately focussed. That the choice of a life-occupation is often influenced by the condition of the sight is a matter of every-day experience, and it would be interesting to have statistics showing to what extent this occurs in the case of myopia. Further, as a man's circle of acquaintance is, for the most part, amongst individuals having similar interests in life, intermarriage in myopic families must frequently occur, and would tend to perpetuate, and perhaps increase, the defect. In savages, on the other hand, where the great principle of the survival of the fittest is not frustrated to the same extent as among civilised races, everything would evidently be against the perpetuation of the myopic type. The question comes to be, then, Is not the absence, or comparatively great infrequency of short sight amongst savages due rather to the requirements of such races being antagonistic to the circumstances which would be most likely to perpetuate the myopic type, than to the fact that young savages are not subjected to compulsory education? The pages of NATURE are perhaps hardly the place to develop very fully a question of this kind; suffice it to say, therefore, that the conclusion which such reflections, as well as the result of every-day examination of cases of short sight, appear to justify, is, that *the increase of myopia is due mainly to the perpetuation of a type through the requirements of civilisation*, and, though not a disease in the ordinary sense, it is desirable to attempt to check its progress. This will assuredly not be an easy matter, but it is not likely to be much influenced by such school reforms as have been introduced into Germany.

Lord Rayleigh mentions, as an interesting subject for further investigation, the slight myopia which he finds not uncommon when the light is lowered in a room, until objects begin to be indistinctly seen. He finds, *e.g.* that though in a good light he sees rather worse with a concave lens of 36 inches focus than without it, yet, when the illumination is diminished, the same lens increases his visual acuity. Altogether, the influence of illumination on visual acuity, and the relation between light-sense and form-sense, are points which have not yet received adequate attention. If the phenomenon described by Lord Rayleigh be really one of short sight occurring under the circumstances mentioned, it is evident that it can only be due to involuntary accommoda-

tion for a nearer point than that on which attention is directed—a kind of spasmodic myopia, and, as such, would disappear when the power of accommodation was paralysed by atropine. On the other hand, it may not be myopia at all, the improvement given by the weak concave lens being perhaps due to the contraction of the pupil, which would occur along with the accommodation necessary to neutralise the effect of the glass. If this were the case, the improvement would also take place by the use of a suitable diaphragm held in front of the eye. Still another possible explanation suggests itself, viz. that the new dioptric combination made up of the concave lens and partially accommodated crystalline might introduce conditions of chromatic and spherical aberration which were more favourable to distinct vision. The disturbing effects of such aberration are probably greatly neutralised by the arrangement of the retinal elements, but the degree of the neutralisation is, not unlikely, dependent on the amount of absolute and relative illumination of contiguous elements. GEO. A. BERRY

Edinburgh

The Fall of Autumnal Foliage

THE paper by Mr. Sorby in NATURE for December 4, 1884 (p. 105) opens up an unpursued inquiry into the cause of leaves falling in autumn. While Mr. Sorby has had his attention drawn to the subject by looking at the actual trees and leaves "of the fine display of autumnal tints which we have lately seen" in England, there is much of both positive and negative evidence to be drawn in two extreme directions—the tropics and the pole.

Being, in the year 1881, home from India, where, it is not necessary to say, nearly all the trees retain their green foliage throughout the year, the writer indulged in a long curiosity to see the counties of Caithness, Orkney, and Shetland He went there with reference to the luminosity, which reaches its maximum in them for Great Britain, and is very marked and exceedingly striking and beautiful as a feature all over the north of Scotland in the month of June, when it is daylight all through the hours of night, sufficiently clear for reading distinct print at twelve o'clock midnight.

A peculiarity of Caithness and the Orkney and Shetland Islands is that no forest-trees can be got to grow. Setting on one side a remark "that it was because nobody had tried," the suspicion had already occurred to my mind that there must exist some other causes than those usually asserted—the high sea winds, bleakness in winter, and extreme cold—for this want of trees.

Any one who has been much in the north of Scotland, and is at all acquainted with the optical sciences, cannot fail to have noticed the immense amount of polarised light there is from the sky; almost all the diffused daylight, except for an hour or two in the middle of the day, being plane or elliptically polarised.

The attention of readers of NATURE may with advantage be specially directed to the possibility, from the phenomena of the north, that leaves fall in autumn from trees growing above a certain latitude—about 30°—through loss of vitality in the more or less highly polarised light.

The first thing a traveller from India notices in Alexandria is the American fall of the leaves in the Grande Place, or, as a fellow-passenger once put it, pointing to these, "It is here trees first become deciduous" It is worth being remarked that, not until reaching Cairo or Alexandria, can sun-protection be done without.

So far Mr. Sorby has to refer to the action of light in the last resort, as he says, with regard to leave , "slight frosts reduce their vitality in such a manner, that the chlorophyll is changed by the action of the light into a red product."

Chlorophyll is composed of carbon, hydrogen, oxygen, and a trace of iron. Chemically it is $C_{18}H_{20}N_2O_3 + O_{18}$, resulting from the action of carbonic acid and ammonia on a fat, $C_8H_{14}O$, under the influence of light, as given by a different authority; but the composition of its products and combinations have not been traced. Still there is almost every constituent of the animal frame present except the earthy salts, and it must be a substance very sensitive to rays of light, or to what light probably is, electro-magnetic forces.

The weakening of the plant is supposed by Mr. Sorby to have occurred, for the leaves of a tree to have lost the vitality which counteracted the chemical degradation of the chlorophyll. Now in India or Ceylon, if a stalk were injured, the leaves would wither into brown. Trees remain, however, when living, constantly green, the leaves dropping off gradually one by one almost, and are immediately replaced. Indian leaves of trees are much thicker, and more of the texture of parchment than those of foliage in European countries, and the phenomena of change can be studied in evergreens without going there, Indian observation merely serving to draw attention that might not otherwise be given to the matter.

The Rothamsted experiments of Sir J. B. Lawes and Dr. Gilbert, F.R.S., bear closely on the question. They found (Swansea, 1880, address) that plants assimilate chlorophyll not only during but a small portion of the year, but the action is limited to the hours of daylight, while during darkness there is rather loss than gain. The experiments, however, both there and in Norway by Prof. Schübeler, were made in ordinary unpolarised solar or electric light.

On the other hand, in India the light is intense owing to its tropical position, and, from the altitude of the course of the sun, very slightly polarised. It is only for an hour at dawn and another hour of sunsetting that the Indian is at all the same sort of daylight that it is in England. It accords with the Rothamsted and Norwegian experiments under the continuous exposure of vegetation to daylight and electric illumination during the night that the trees in India are large and evergreen. Of course in time leaves have done their work and fade, but as they have not been unfolded simultaneously, they drop off gradually in batches.

Where, accordingly, the light is polarised, trees are scarce or absent, mown by a swathing light; and in the tropics, where there is little polarisation, they are luxuriant, and green all the year round.

This is not inconsistent with fact. To begin with, plane polarised light has half the intensity of ordinary white light, the set of vibrations at right angles to the plane of polarisation being absorbed in the reflecting matter of the sky. Besides, circularly or elliptically polarised light must largely prevail, to judge from the metallic glow there is on the Pentland Firth, Orkney, and Shetland in midsummer, and what effect circularly polarised light has on the assimilation of carbon in the leaves of plants and decomposition of chlorophyll is unknown.

At any rate, Caithness, and the northern islands have a number of hours in the daytime of a wintry darkness, and scarcely any light in the summer months and its long days that is not polarised. From this cause, which could in the leisure of their winter be put in arithmetical units of force, combined with cold winds and a thin soil, without alluvial deposits, resting on stone, it is no wonder that, though the inhabitants are not strangers to the pathos of the fall of the leaf, the Caithness-shire landscape, and the sward and heather of Orkney and Shetland are lustrous day and night with polarised light, and bare of autumnal foliage. A. T. FRASER

India, January 22

Erosion of Glass

IN reference to the letter of Dr. Ord in last week's NATURE, glass is by no means proof against the action of either acids or alkalies, indeed its resisting seems to depend merely on its colloidal, at any rate non-permeable, nature. It may not be generally known that water alone very rapidly acts on glass, especially when it is in a finely divided state, extracting both alkalies and silica in quantity. It would be rash to put down the action of substances on glass to "molecular coalescence" to the exclusion of chemical action, or under the idea that acids or fluorine are necessary to etch glass. Alkaline salts, especially phosphates, act, either wet or dry, very vigorously on glass. One class of salts, the potassium salts of phenol sulphonic acids, have been noticed to literally tear a glass bottle in pieces, whilst crystallising out of an acid solution. Ordinary gum is often acid in reaction; but the ordinary mechanical action of sticking and then contracting is probably quite sufficient to cause an abrasion or etching, especially with soda-glass. This purely mechanical action is often noticed in the distillation of tarry substances which solidify at a high temperature, the whole interior surface of the retort being torn off and cracked in all directions. W. R. H.

A Lantern Screen

THE optical lantern has come to be so much used for scientific and educational purposes, that you may perhaps think it useful

to your readers that a screen, whose valuable properties seem even now to be scarcely at all known, should be noted in your columns.

It simply consists of a sheet of French tracing-paper, of a kind which possesses a remarkably dull, non-reflecting surface. With this screen and only an oil-lamp lantern, it is quite easy to show pictures well to a couple of hundred people in a room fairly well lighted—sufficiently lighted indeed to enable note-taking or reference to books to be accomplished with perfect ease—provided that extraneous lights are not placed *behind* the screen.

It was to Mr. George Smith, of the Sciopticon Company, that I was indebted, four years ago, for the knowledge of this fact; which, with considerable lantern experience, I scarcely knew how to believe, until I had myself verified it.

At present, however, the tracing-paper cannot, I believe, be obtained more than three to four feet square.

CHARLES J. TAYLOR

Toppesfield Rectory, Essex, February 17

Fuller's Earth as a Filter

WHERE the *fuller's earth* is dug from the Bedfordshire greensand it is held in much repute for its efficacy in removing impurities from turbid water.[1] In addition to the other uses to which it is here applied, dealers take it around through the fen countries, and dispose of it for clarifying the peaty water,[2] often the only supply obtainable in those districts.

I shall esteem it a favour on the part of the readers of NATURE residing on the Greensand or Oolites of the southern counties to notify if these filtering properties of the Bedfordshire fuller's earth are in any way unique—in so far as they appear withheld from that of other places?—as at Reigate, Bath, &c., where fuller's earth is known to them to be dug.

Bedford, February 23 A. G. CAMERON

The Boomerang in India

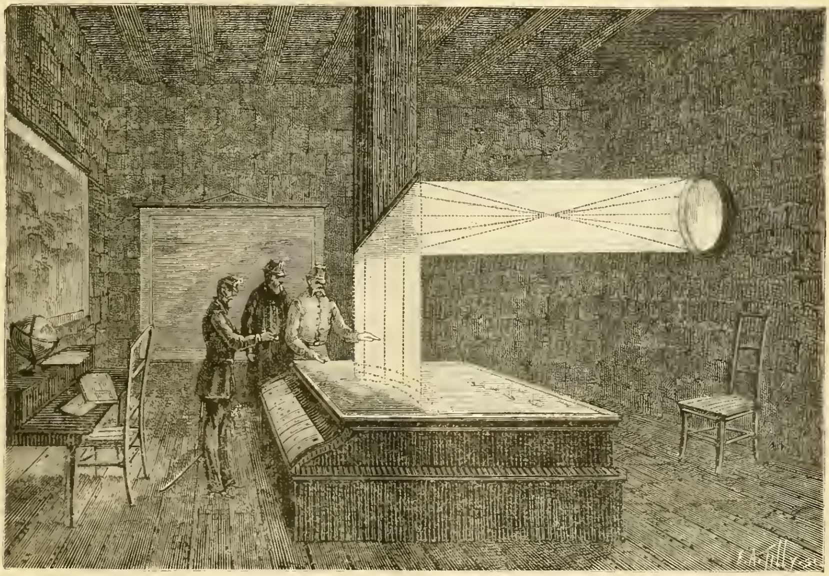
IN Gustav Oppert's work "On the Weapons, Army Organisation, and Political Maxims of the Ancient Hindus," the boomerang is mentioned as being among the weapons, especially in Southern India, and made of various materials—iron, ivory, and wood. Are any specimens to be found in our museums here, or would any private persons who may happen to possess any, kindly allow me to inspect them?

ARTHUR NICOLS

THE CAMERA OBSCURA IN TORPEDO WORK[1]

AT the time of the last Austro-Italian war, in 1866, the Austrian Government made the greatest efforts to protect its harbours from an attack of the Italian fleet. Torpedoes were placed in great numbers in the harbours, and the greatest vigilance was enjoined on all the commandants of such places.

The accompanying illustration represents a novel application of the camera for use at the observing or firing post of a party belonging to the military telegraph. The torpedoes are placed along certain concentric lines, very close to each other, and at a certain depth below the sur-



face of the water, no sign of their presence being apparent. A metallic wire connects each of them with a post of observation situated on the coast at a point sufficiently elevated to permit of the port being seen. According to well-known optical laws, an image of the port is formed on the glass. Black points marked on that image indicates the exact position of each torpedo; these points are all numbered, each number corresponding with that on a particular key of a keyboard. To press one of these keys with the finger is sufficient to place the corresponding

[1] From *La Nature*.

[1] *Geol. Mag.*, February, 1885.
[2] A brief account of the method in use in the fen districts of Cambridgeshire and Lincoln will appear shortly.

torpedo in communication with an electric battery, by means of a metallic wire which connects it with the port, and so cause an explosion.

THE CONTINUITY OF THE PROTOPLASM IN PLANT TISSUE

THE translation of Dr. Schaarschmidt's paper in a recent number of NATURE (January 29th, 1885) gave those who, like myself, are unable to read Hungarian, full details both of his researches and views, and as one much interested in the subject of "the continuity of the protoplasm," I should like to be allowed to make a few remarks upon it.

To refer first of all to a matter of minor importance with reference to sieve-tubes, I see that Dr. Schaarschmidt says: "The first direct observation was made in 1854 by Hartig, and not by Sachs, as Walter Gardiner states." This refers to the opening passage of my paper in the *Arbeiten des Botanischen Instituts in Würzburg*, Band III., Heft I., where I say: "A most important addition was made to our knowledge of the histology of tissues in 1863 by Sachs, and in the following year by Hanstein, when they demonstrated that in the sieve-tubes first described by Hartig there are perforations in the transverse walls, &c." I made that statement, relying, as I still do, on the authority of Prof. Sachs's text-book (English edition, 1882, p. 89), since it seemed to me that Hartig's observation, which could not be confirmed by "Mohl and others," was actually proved and demonstrated beyond doubt by Sachs and Hanstein, and, moreover, in fresh and not in macerated tissue.

With respect to the main subject under immediate consideration, I shall first make one or two general statements as to the continuity of the protoplasm in plant tissues. In my paper in the *Würzburg Arbeiten*, to which I have already referred, I have spoken of two appearances of continuity: one which I speak of as direct, and the other as indirect. By direct or unbroken continuity, I mean the appearance of a thick protoplasmic process, extending between, and uniting the protoplasmic contents of two contiguous cells: the pits forming one continuous canal, and being uninterrupted by a pit-closing membrane. In this case, therefore, the idea of open pits is necessitated. By indirect continuity I mean the existence of a pit-closing membrane between the two opposite protoplasmic processes in the pits: the membrane being perforated in a sieve-like manner, and thus allowing the two protoplasmic processes to become united to one another by means of delicate protoplasmic filaments which traverse the pit-closing membrane. I further stated that my observations led me to believe that a pit-closing membrane was present in all cases, and that the appearance of a direct unbroken continuity is fallacious. (See also *Roy. Soc. Proc.*, December 13th, 1883.)

Turning now to the consideration of the observations made upon the Florideae, I shall have to differ somewhat with Dr. Schaarschmidt; but, while I do so, I wish it to be quite clearly understood that I do not in the least undervalue the work of those investigators to whom I refer, and who, according to my view, have not actually demonstrated a continuity of the protoplasm from cell to cell, but have only observed facts which render the existence of such a continuity extremely probable. Thus, since I regard the perforation of the pit-closing membrane as proving continuity, I hold that the observations of Bornet, Perceval Wright, and Agardh (I have unfortunately not seen Kolderup-Rosenvinge's paper) have not demonstrated continuity, but have demonstrated that the pit-protoplasm clings with remarkable tenacity to the pit-closing membrane. Hick has simply repeated the observations of these investigators, and of his results the same may be said. Since, therefore, Schmitz (1883) has found that a pit-closing membrane does exist; that it is perforated in a sieve-like manner, and that therefore the continuity is not direct, but indirect, it seems to me that to him alone belongs the credit of having demonstrated the continuity of the protoplasm in the Florideae, and I have myself (*Proc. Camb. Phil. Soc.*, February 11th, 1884) been able to confirm his results as to the existence of the closing membrane in question.

In considering the history of the subject, and leaving sieve-tubes out of the question, it is clear that Tangl's observation (1880) on the endosperm cells of *Phœnix* and *Strychnos* was the first new discovery in the direction of the continuity of the protoplasm between neighbouring cells. Then came Strasburger's classic work on the cell-wall ("Bau und Wachsthum der Zellhäute," 1882); his observations on the porosity of the pit-closing membranes, and his valuable suggestions as to the probability of cell-wall perforation, together with the citation of instances which already occurred, and his extremely interesting observation with regard to the swarm-spores of *Vaucheria.* Naturally *Volvox*, *Pandorina*, and the zoospores of *Hæmatococcus* offer other examples of the perforation of the cell-membrane by protoplasm.

After Strasburger came Russow. Russow read his first paper at the January meeting of the Dorpat Society (*Sitzber. d. Dorpater Nat. Gesell.*, 1882), but it did not come into my hands until some time after I had published my first observation (*Quart. Jour. Mic. Sci.*, October, 1882), so that, at least from that point of view, my work was quite independent and original. As to the order of the other papers, I agree with Dr. Schaarschmidt, except that I would like to add to his list the papers of Pfurtscheller (*Selbstverlag des k. k. Franz Joseph Gymnasiums*, 1883), Will, (*Bot. Zeit.*, 52, 1884), Tangl (*Sitzb. der k. Akad. der Wiss.*, Bd. 90, 1884), and Goroschankin (*Bot. Zeit.*, 41, 1883).

As to Dr. Schaarschmidt's claiming, in 1884, the suggestion of the universality of the occurrence of continuity of the protoplasm in plant-cells, I think that, considering the state of the subject at that time (April, 1883) something may also be said in my favour, for I find in my Royal Society paper (*Phil. Trans. Roy. Soc.*, April, 1883) the following statement:—"Although I am aware of the danger of rushing to conclusions, I cannot but remark that when these results (which were foreshadowed by Sachs and Hanstein, when they discovered the perforation of the sieve-plate) are taken in connection with those of Russow, it appears extremely probable that not only in the parenchymatous cells of pulvini, in phloem parenchyma, in endosperm cells, and in prosenchymatous bast fibres, is continuity established from cell to cell, but that the phenomenon is one of much wider, if not of universal, occurrence."[1]

Passing on to the results of Dr. Schaarschmidt's second paper, to which he refers, where he gives a very long list of tissues in which he has demonstrated the existence of a continuity of the protoplasm, I should only wish to remark that while he appears to have observed in a satisfactory manner, and with comparative ease, cases that have appeared to me to be excessively difficult, yet his figures of such continuity are not satisfactory, and in many of them it is the direct and not the indirect continuity which his drawings represent. As I have stated elsewhere (*Arb. d. Bot. Inst. Würzburg*) an examination of fresh unswollen tissue with iodine and chlor. zinc. iod. will always demonstrate the presence of a pit-closing membrane.

I now come to a subject which I approach with some regret, since, in dealing with it, I have to dissent from the expressed opinions of a number of competent observers, and especially do I feel this regret with regard to one of those papers—viz. that by one of the most distinguished

[1] Mr. Dyer has already very kindly alluded to this subject on my behalf. It will be observed from the text that at that time (April, 1883), owing to the hurry of publication I had not referred to Hartig's paper (February 18, 1885).

investigators of plant histology: Prof. Russow. The subject is that of the existence of intercellular protoplasm.

Dr. Schaarschmidt has already given the literature. The only other observation with which I am acquainted is that of Prof. Frommann ("Zur Lehre von der Bildung der Membran von Pflanzenzellen"—separate pamphlet) who finds in the intercellular spaces of the young stem of *Ricinus communis*, protoplasm; starch grains, and chlorophyll grains.

The observations as to the existence of intercellular protoplasm depend chiefly upon the staining reactions of iodine and sulphuric acid or chlor. zinc. iod. The cell wall turns blue, or remains yellow as the case may be: the protoplasm, and in certain cases a substance; in or lining the intercellular spaces, stains dark brown. Or again in some instances—*e.g.*, the rhizome of *Aspidium filix mas*—the substance in the intercellular space remains uncoloured. Other observers have employed other staining reagents after swelling with sulphuric acid and chlor. zinc. iod.—*e.g.*, saffranin, eosin, or anilin blue—and in this case a colouration is observed of the protoplasm on the one hand and of the intercellular space substance on the other.

Dealing first with the iodine and sulphuric acid or chlor. zinc. iod. method, it is obvious that, besides the protoplasm which assumes the well-known dark brown colouration, any lignified, cuticularised or suberised membranes would react in the same way, and in the case of one of Berthold's (*Ber. d. Deut. Bot. Gesell.*) examples, *e.g.*, young stem of *Ligustrum vulgare*, the substance which so markedly stains, does actually consist of the external membrane of the intercellular space, which towards the free surface has undergone changes associated with partial lignification (Gardiner, *Proc. Camb. Phil. Soc.*, Nov. 10th, 1884), as can be readily proved by treating a section with aniline chloride and hydrochloric acid, when the well-known gold yellow reaction of lignified tissue appears. In the same way the substance which does not stain with iodine and sulphuric acid might be of a mucilaginous nature, and like the mucilage of the external portions of the wall of the seed of *Ceratonia siliqua* give the same reaction, viz., remain uncoloured. But there are cases which are not so easy to deal with, as I have stated elsewhere (*Proc. Camb. Phil. Soc.*, Feb. 11th, 1884), I found that the Hofmann's blue which I had so successfully employed for demonstrating the existence of protoplasmic filaments in the pit-closing-membrane stained not only protoplasm but also certain forms of mucilage. Like Russow (*Sitzber. d. Dorpat. Naturfor.*, Sept., 1883), I thought at first that in *Aucuba Japonica* I had discovered the existence of intercellular protoplasm, but I observed later on that this staining substance could be seen to arise as drops on the external walls and that these drops went blue with iodine: thus demonstrating that they were not protoplasm but mucilage. I therefore made experiments with the methylene blue which I had found (*Phil. Trans.*, part iii., 1883) to be so useful as a stain for the cell wall, and so differentiating in its action. (A solution is made in water containing a trace of alcohol; the solution being diluted with water before use. The section freed from alcohol by repeated washing, is left to stain for about 20 seconds, washed and mounted in water). I further found that methylene blue stains equally well, all substances formed by the degeneration of cellulose walls, such as mucilage and the like. So while Hofmann's blue stains protoplasm and mucilage, but not cell wall, methylene blue stains cell-wall and mucilage but not protoplasm. Thus the cell-wall and protoplasm may be readily discriminated in a very satisfactory manner, and without this reaction it would indeed be hard to distinguish the two. Many dyes behave like Hofmann's blue so far as the staining of the mucilage is concerned, and I have little doubt but that eosin resembles it in this respect, though not such a good differentiating stain for the protoplasm. In the course of all my experiments, which I have repeated several times, I have never found intercellular protoplasm but often intercellular mucilage. In all cortex tissues which are often remarkable for their mucilaginous character—*e.g.*, *Viscum*, *Fraxinus*, *Ilex*—mucilaginous degeneration of the free cell-walls very usually occurs, which often—*e.g.*, *Ilex*, *Viscum*—extends even to the whole middle lamella. In *Aspidium filix-mas*, *Blechnum Braziliense* and other ferns, theso-called cuticularised threads (cuticularfäden) are in reality rods consisting mainly of mucilage which arise as drops on the free surface of the cell-wall and increase in length by repeated basipetal formation. I do not therefore find myself able to allow of the existence of intercellular protoplasm.

As to the middle lamella being protoplasm I can only refer to the statements I made with regard to Frommann and Elsberg's researches (*Quart. Jour. Mic. Sci.*, March, 1883) and I share fully in the opinion of Prof. Russow ("Ueber die Auskleidung der Intercellularen," *Sitzber. d. Dorpat. Naturfor.*, August, 1884) that if such were the case it is clear that we could have no such thing as a mass of tissue resisting great stress. The cells cannot be connected together by protoplasm. As to the existence of the intercellular chlorophyll grains of which Dr. Schaarschmidt speaks, and the chlorophyll grains and starch grains observed by Prof. Frommann, I also share Prof. Russow's view (*loc. cit.*) that the above investigators must have been deceived by some abnormal appearance, for what could be the physiological significance of such a phenomenon? The full details of my researches on the subject will, I hope, shortly appear in the *Quarterly Journal of Microscopical Science*. WALTER GARDINER

Botanical Laboratory, Cambridge, February 10

THE BANGOR LABORATORIES

THE following is a description of the Laboratories of University College, Bangor, which were opened by Sir William Thomson on the 2nd inst. The illustration shows the ground floor arrangement; in the upper floor are a magnetism-room and an optical gallery.

The new physical and chemical laboratories occupy the site of the old stables and coach-houses of the "Penrhyn Arms Hotel," which is now used as the main building of the College; and, to lessen expense, a plan has been adopted by which the old walls are, as far as possible, taken advantage of for outside walls and partitions. To utilise the available space to the utmost it was decided to roof in the whole area, which measures about 120 feet by 80 feet. This area is bounded on the east by the main building of the College; on the south by a private road which runs nearly parallel to the Shrewsbury and Holyhead turnpike road, and gradually ascends until opposite the laboratories, the ground is about 20 feet above the level of the turnpike; on the west and north by the private grounds of the College.

At the extreme east end of the south front of the laboratory buildings is a wide door opening into a vestibule, from which a passage leads north, and terminates in a wider space or hall. From this hall a long corridor runs parallel to the south front, dividing the floor space into two nearly equal parts. Of these the southern is set apart for physics, the northern for chemistry.

The physical and chemical lecture-theatres (23,41) are of the same size, 32 feet square and 19 feet high, and are placed side by side with the corridor as a separating space between them. The internal arrangements are nearly the same in both rooms. The students' entrances are opposite one another in the corridor. The benches, eight in number, rise from the front to the back of the room, and front toward the west. The lecture-tables are placed about 4 feet from the front bench, and between each table and the west wall there is a clear space between 7 and 8 feet wide. In the physical lecture-theatre the table is supported on four pillars of masonry, and is en-

tirely independent of the floor of the room. The tables differ somewhat in their arrangements, one being designed specially for chemical, the other for physical, work. Both have been fitted with the most recent improvements, and some novel appliances.

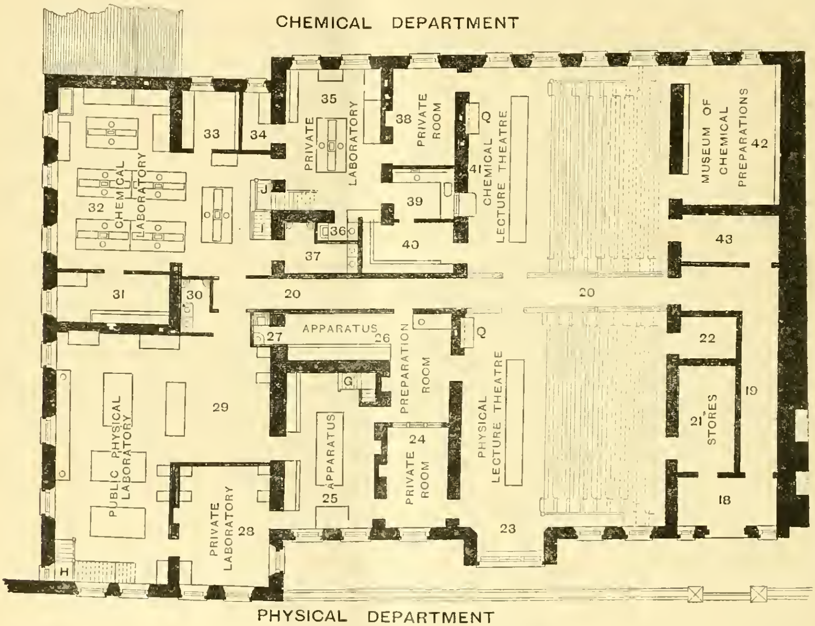
At the south end of the physical lecture-theatre, opposite the end of the lecture-table, is a large window filled with plate glass, and projecting so as to give additional space within the room for experimental work. A stand for a heliostat is fixed outside, and a table for optical instruments will be placed in front of the window inside.

An open space, extending to the ridge, and about 12 feet square, has been left above the centre of the physical lecture-table, and in this way a clear height of about 30 feet has been obtained for long pendulums, vibrating cords, &c. A gallery surrounds this space near the top to allow the beams, from which such appliances are suspended, to be easily reached.

By means of blinds, working on spring rollers controlled by cords from one place near the table, the windows of each lecture-theatre can be completely darkened in an instant.

A passage leads from each lecture-theatre to the space beneath the benches, which has been utilised for storage, and gives access to two rooms behind. In the physical department these are diagram-room and store-room (21, 22); in the chemical department store-room and class museum (43, 42), respectively.

In each department the space intervening between the lecture-theatre and the public laboratory is occupied with the professor's private room and laboratory, and the preparation and apparatus rooms. On the physical side, im-



The New Laboratories of University College, Bangor.

mediately to the west of the lecture-theatre, are the private room and preparation room (24, 26), which communicate directly with the lecture-theatre. Beyond the private room is the apparatus room (25), which overlaps the preparation room, and communicates directly with it. The preparation room is L-shaped, one limb of the L running back along the north wall of the apparatus room. This part of the room is open to the roof, to allow the room to be lighted by a window at the west end, placed above the level of the western part of the building, and by a large skylight, and is fitted along one side with cases as a supplementary apparatus room. An available height of about 25 feet is obtained in front of these cases, and is designed for elasticity experiments. A gallery over the window allows the roof above this part of the room to be reached by means of a ladder. The limb of the L immediately behind the lecture room is fitted with a work-table and provided with a fireplace, as a preparation room for the lecture experiments.

To the west of the apparatus room is the private laboratory (28), about 20 feet by 18 feet, communicating with the preparation room and private room on one side, and with the public laboratory (29) on the other. In the south-west corner of this room a slate balance table has been built into the wall, and near the other end of the room slate tables have been fixed to the wall for galvanometers and electrometers. A single work-table, fitted with gas, occupies the centre of the room, and a smaller work-table with gas and water the south-east corner.

The general physical laboratory (29) is a large room over 1000 feet square in area, running along the west end of the space allotted to the physical department. The

student's entrance is from the corridor, and adjoining this entrance is a lavatory and cloak-room (30) for their use. The laboratory is fitted with work-tables for about twenty students. Along the west wall is a long work-table, fitted with gas and water. The space below this table is divided into cupboards and drawers for the use of students. On the north wall a draught chamber, and combined heating store and sand bath, of novel design, have been provided, and at different positions slate slabs for galvanometers, &c., have been fixed to the walls as in the private laboratory. The roof is left open to add to the height of the room, and for convenience for experimental arrangements. The room is lighted by windows in two sides, and by a row of large skylights on each side of the ridge.

A staircase, G, leads from the apparatus room to two rooms on the second floor. One of these has been constructed without iron to ensure a uniform magnetic field. No magnets or a large mass of iron will be stored below, and the room will be available for absolute electric measurements. The other room is a gallery about 37 feet long and 10 feet wide, constructed for optical and photometric work.

A second stairway leads to a small room communicating with the gallery above the lecture table, and with a flat space on the roof which has been constructed as a station for observations of atmospheric electricity. The collector of electricity will be placed outside on the flat roof, and connected with a station electrometer in the small room below.

A stair, H, at the south end of the general physical laboratory leads to some valuable rooms in the basement, which have been set apart for practical electricity, workshop (with lathe and forge), magnetic room, battery room, store room, &c.

Returning to the chemical side, the preparation and apparatus rooms (39, 40) occupy the position corresponding to that of the preparation and elasticity rooms on the physical side. The preparation room is fitted with proper work-tables, and communicates with the lecture-theatre by a sliding panel. The private laboratory (35) corresponds to the apparatus room of the physical department. It is fitted with a work-table for four persons, and a large draught chamber and sand bath, and communicates with a special balance room (34) on the west side. The general chemical laboratory (32) corresponds in position with the physical laboratory, and is fitted with work-tables for twenty-four students. These tables have been constructed according to a special design embracing all the most recent improvements. Around the north end of the laboratory have been placed sand baths, draught chamber, large distilling table, sink and table for water and air baths. A portion of the south end of the laboratory has been partitioned off and fitted up as a combustion and blowpipe room (31). At the north end a balance room (33) has been fitted up, and in this room, as well as in the private balance room, the floor is completely isolated from the laboratories, and the tables for the balances are supported on strong brackets firmly fixed to the stone walls. The lighting of the laboratory is managed in the same way as that of the physical laboratory, the skylights along the east side of the ridge of the roof being made to open.

A staircase, J, leads from the general laboratory to the first floor of the chemical department, which is occupied with rooms specially designed and fitted for photographic, gas analysis, and spectroscopic work respectively. A ladder leads to a flat roof for experiments which require to be made in the open air. A second stair, I, leads from the general laboratory to the basement, where there is a rough operation room, joiners' shop, and metallurgical room.

The arrangement of the rooms and the construction of the lecture tables, work-tables, and other fittings have been carried out by Mr. Richard Davies, architect, Bangor, under the direction and superintendence of Profs. A. Gray (Physics) and J. J. Dobbie (Chemistry), and in accordance with sketch plans furnished by them.

The addresses on Scientific Laboratories which Sir William Thomson delivered on the opening of the above laboratories we shall give in our next number.

NOTES

THE Geological Society has this year awarded the Wollaston Medal to Mr. George Busk for his researches on Fossil Polyzoa and on Pleistocene mammalia; the Murchison Medal to Prof. Ferdinand Roemer, the eminent palæontologist of Breslau; the Lyell Medal to Prof. H. G. Seeley, for his long-continued work on Fossil Saurians; and the Bigsby Medal to M. Renard, of the Brussels Museum, on account of his petrographical researches.

THE annual meeting of the Paris Academy of Sciences was held on February 23 before a very large audience. M. Rolland, the President for 1884, was as usual in the chair. He delivered the customary address, alluding to the members of the Academy who died during the past year, and gave a *résumé* of the principal scientific facts of the same period. M. Arago (Emmanuel), the eldest son of François Arago, who is French Ambassador to Berne, had come to Paris in order to be present at the delivery of the *éloge* on his illustrious father, who died thirty years ago. The delay must be attributed to the political career of the Perpetual Secretary of the Academy of Sciences, who, having been a member of the Government of the second French Republic, was not a *grata persona* to the then authorities. The speech was delivered by M. Jamin, who was one of his successors in the seat he occupied in the section of Physics. M. Bertrand fills his place as Perpetual Secretary. The number of prizes delivered is too great to be reported at full length. We must content ourselves by mentioning the laureates who have worked at questions of general interest. A part of the prize of 6000 francs for progress in efficiency of naval forces has been awarded to the Hydrographic Mission to Tunisia, and to a work of M. Baills on artillery. The Monthyon prize has been awarded to M. Riggenbach, a Swiss engineer, for his railways in mountainous districts. The Poncelet prize, for progress in mathematics, to M. Houel, for the whole of his works. The Lalande prize, for astronomy, to M. Radau, for a memoir on refractions; and the Salz prize, for the same science, to M. Gurzel, for a disquisition on ancient eclipses in order to determine the value of the secular acceleration of the motion of the moon. The Tremont prize has been awarded to M. de Taste for his works on meteorology. M. Marsault has received a gratification of 1500 francs for his studies on lamps for miners. This gentleman is director of the Bessages collieries. The cholera prize was not awarded. M. Durand-Claye, an engineer of the Municipal Service of Paris, who is a strong supporter of the system called "*tout à l'égout*," took a prize of statistics for his researches on diffusion of typhoid fever.

MR. ALEXANDER AGASSIZ has resigned his position as a Fellow of Harvard College, and *Science* states that his resignation was naturally accepted by the Corporation with great reluctance. The *Bulletin* of the University just published contains the formal notes taken at the meeting of October 24, which state "that the wide range of his sympathies and interests, the confidence and affection which he inspired, and the varied information which he possessed both as a man of business and as a man of science, made his services as a fellow of singular value to the University; that his great gifts within the past thirteen years to the scientific departments, and especially to the Museum of Comparative Zoology, which amount to more than half a million of dollars, make him one of the chief benefactors of the University, and entitle him to its profound gratitude."

THE death is announced, at Cannes, of Mr. John Francis Campbell of Islay, at the age of sixty-four years. Mr. Campbell did work in various departments of science. Many years ago he collected the folk-lore of the Western Highlands, and published a large selection of his collections. Mr. Campbell was also a geologist, and in his "Circular Notes" and "Frost and Fire" will be found many geological notes as well as speculations. Quite recently, also, he published a curious book on "Thermography," and he was the inventor, our readers will remember, of the sunshine-recorder at Kew.

WE regret to learn of the death of Mr. Thomas C. Archer, Curator of the Museum of Science and Art, Edinburgh.

M. POYDESSAU, the French engineer who assisted Lieut. Bonaparte Wyse from 1876 to 1878 in his surveys of the Isthmus of Panama, in view of a canal to connect the Atlantic and Pacific, died at Panama on January 7.

Die Natur announces the death of Dr. Friedrich Ritter von Stein, Professor of Zoology in the University of Prague, who is known by a work on Infusoria; and of General Sonklar, one of the first and oldest of Austrian Alpine climbers, whose orographic work in connection with the Austrian Alps has gained him much credit in his native country. He was Professor of Geography at the Military School of Vienna; his latest work was a chart of the rainfall of the Austro-Hungarian Monarchy.

WE learn also of the death of M. Louis Godard, the aëronaut. In 1863 he and his brother Jules went up with Nadar, who still lives, in the monster balloon called *Le Géant*. A breakage in the mechanism necessitated a speedy descent, during which a gust of wind turned the car upside down. The thirteen passengers had barely time to cling to the ropes, and, the grappling irons breaking, the car dragged half a mile on the ground before a landing could be effected. During the siege of Paris Godard left by balloon, and at Tours served on an aëronautic commission. He took no part in recent experiments and discussions on navigable balloons.

ON the afternoon of January 19, we learn from *Science*, the first balloon ascent ever made in the United States solely in the interest of meteorology took place at Philadelphia. Gen. Hazen, chief Signal Officer, U.S.A., recognising the importance and value of a more complete knowledge of the upper atmosphere, entered into a contract some time ago with the well-known aëronaut, Mr. S. A. King, for a number of "trips to the clouds," an ascent to be made at any time on eight hours' notice. The U.S. Signal Service has had this subject under consideration for several years. Prof. Abbe began in 1871 to collect meteorological records made in balloons. In 1872 the records of fifty ascents had been tabulated, studied, and valuable results obtained. In 1876 1000 small balloons were sent with the *Polaris* expedition, to be used in determining the height of the clouds; but, owing to an unfortunate accident, they could not be utilised. At various times the chief Signal Officer has sent observers on balloon excursions which were made for purposes other than scientific. The considerable certainty with which the movement of a storm can now be predicted renders it possible and desirable to make systematic use of the balloon in the study of unusual atmospheric conditions, and the series of ascents just begun is planned with that end in view. Among other things it is desired to determine the difference in the temperature gradient in well-defined "high" and well-defined "low" pressures. For this purpose it is necessary to foretell the arrival of a particular atmospheric condition at Philadelphia, from which place the ascents will be made. This can readily be done so as to give the aëronaut eight hours' notice for the preparation of his balloon, and the observers who accompany him sufficient time to reach Philadelphia from Washington. The first ascent was expected to be rather experimental and suggestive in its character. It was the intention to start at 7 a.m. on the 19th, and a telegram to that effect was sent to Mr. King, who responded that he would be ready. But, owing to the extreme cold, it was found that the balloon could not be handled for filling without danger of cracking; and waiting for the sun to warm it up caused so much delay, that the start was not made till 4.15 p.m. The balloon was the *Eagle Eyrie*, holding 25,000 cubic feet when filled, and having a lifting power of about 1000 pounds. The occupants of the car were Mr. King and Private Hammond, a skilful observer detailed from the office of the Chief Signal Officer for the purpose. Mr. Hammond carried with him a complete outfit for making barometric, thermometric, and hygrometric observations. Owing to the late hour of starting, the observations made were not so numerous as could be desired, although seven complete sets were obtained before darkness rendered further reading impossible. A safe and quiet landing was effected at about 7.30 P.M. near the village of Manahawken, on the New Jersey coast. The greatest height reached was somewhat over one mile. This trial-trip has suggested some modifications in the plans, which will render future ascents more successful. The danger incident to a balloon ascent is greatly over-estimated by many. In the company of an experienced and skilful aëronaut the risk to life and limb is hardly greater than on a railway train or a steamboat. Volunteers for this service are by no means wanting among those connected with the signal service; and Prof. Abbe is so desirous of knowing what is going on "inside of a storm," that he means to make an ascent himself in order to find out.

THE Faculty of Harvard College, by a majority of thirty to two, have decided that Freshmen may be admitted without matriculating in Greek. It is expected that the Classics will soon suffer a further comparative decline, the literature and history of the United States being given greater prominence in the curriculum.

AT a meeting of Convocation of the London University, held on Tuesday, Lord Justice Fry moved, "That, in the opinion of Convocation, the objects of the Association for promoting a Teaching University for London would, if carried into effect by this University, add to its usefulness and importance." His Lordship said that, while he did not wish to cast the slightest slur on the past history of the University, he maintained that there should be a combination of teaching with examination. In his opinion the success of the scheme was inevitable, and it would be far better that it should be carried out by the University than by another examining body. The motion having been carried, the Special Committee was authorised to give effect to the resolutions passed.

THE December number of Prof. Caporali's *Nuova Scienza*, which completes the first year of this remarkable publication, continues to advocate his peculiar system of the universe with unabated vigour and learning. His theory of psychogenesis is here advanced a further stage, and it is now contended not only that psychis is co-eternal with matter, but that it is the true starting-point of all evolution. In the present issue the chief articles are: "Modern Italian Thought," "The Pythagoric Formula of Cosmic Evolution," and "The Anglo-Saxon Anticlerical Evolution." Notwithstanding some curious misconceptions, the last mentioned paper will be read with interest by English students of contemporary thought.

AN extensive Fish Culture Establishment is in course of construction at Delaford Park, Iver, Buckinghamshire, in connection with the National Fish Culture Association. The site is situated close to the River Colne, which is famous for its trout, and affords an abundant supply of fresh water for the purposes required. A number of ponds are being formed upon the most approved scientific principles, in which the various species of *Salmonidæ*, coarse fishes, &c., will be propagated for the benefit

of the community at large. The cultivation of the German carp will also receive considerable attention, this fish being far superior to the English species both as regards its edible qualities and capacity for rapid growth.

WITH a view to effectually prosecuting marine fish culture on sound scientific principles, the National Fish Culture Association have under consideration a scheme for carrying out a series of observations on the temperature of the sea at various stages, in order to obtain a more thorough and concise knowledge of fish, their habits, food, &c. Thermometers for this purpose are in course of manufacture, and will be distributed to those selected for observers under certain rules and regulations. The Duke of Edinburgh is greatly interested in the subject, and has promised his co-operation in furthering the movement, which he considers a most important one.

LARGE consignments of eggs of the *S. levenensis* and white fish have lately been received at the South Kensington Aquarium from the Hon. Prof. Baird, Commissioner of Fish and Fisheries in the United States. All the eggs are in a healthy condition and on the point of incubation. There have been about a dozen premature births amongst them, but, of course, the young fry so born will not live. Prof. Baird has intimated his intention of forwarding a further instalment to South Kensington shortly.

DR. A. WOEIKOFF writes with reference to a note in NATURE for January 29 (p. 298), in which it is stated that the Russian Government are preparing an expedition to Western Siberia to examine the sulphur deposits mentioned by MM. Kalitin and Koushin. These deposits, he states, are not in Western Siberia, but on the so-called old beds east of the Caspian, in a region which it is usual to call Central Asia. It is not exact also to mention the deposits of Tchirkat (*not* Tchirkoto) in Daghestan as the *only* ones till now known in Russia. Sulphur deposits are known in some places near the Volga, and are due to the decomposition of the gypsum so often met with in the Permian formation. Two of these have been worked, one in the eighteenth century, that of Sernaja Gora, on the right bank of the Volga, somewhat above Samara, and another quite recently, that of Sukeewa, about 20 versts above the town of Tetjuchi, government of Kasan.

BEFORE a recent meeting at Annisquam, on the coast of Massachusetts, Mr. J. S. Kingsley described the foundation and work of the Annisquam Marine Laboratory. Prof. Hyatt, of Boston, had been in the habit of inviting some of his students to accompany him to this place during the summer to study the marine forms so abundant there. From the number of applications it appeared that there was a demand for a marine laboratory on the coast near Boston which should be practically free to all. The Woman's Educational Society of Boston became interested in the project, and advanced the money necessary to fit it up. It is under the charge of the Boston Society of Natural History, and was first opened for students in June, 1881. The object of the laboratory, which appears to be open only during the summer vacations at the colleges, is to furnish students with an opportunity of studying marine animals and plants in the best possible manner. Some of those who enter are competent to conduct original investigations, and they are left to follow out any line they may choose. The majority, however, attend to get a foundation and to fit themselves for teaching. Mr. Kingsley describes the aim of the laboratory to be to teach the structure and development of animals, and the methods of study best adapted to produce teachers and investigators. Each student, unless previously qualified, dissects a series of types of the larger forms, such as sea anemones, starfish, clams, lobsters, squid, &c. After this comes a drill in the methods of investigating the embryology of marine forms. The numbers of students range between nine and twenty-one. The laboratory is under the immediate charge of Mr. B. H. Van Vleck. A windmill has lately been added to pump salt water into the building, thus supplying a tank on each of the tables, besides three large aquaria in the centre of the room. The object was to keep the specimens studied alive in confinement—a task of no small difficulty.

AT a meeting held at Edinburgh on Monday it was resolved to hold an international exhibition in that city in the summer of 1886 of industry, science, and art. A committee was appointed to carry out the details.

THE Prince of Wales, as President of the International Inventions Exhibition, has delegated to a Commission selected from among the members of the Executive Council the duty of making arrangements for the effective carrying out of the work of the International Juries. This Commission consists of Sir Frederick Abel (Chairman), Sir P. Cunliffe-Owen, Sir George Grove, Sir E. J. Reed, M.P., Mr. John Robinson, Mr. R. E. Webster, Q.C., with Mr. Trueman Wood (Secretary of the Society of Arts), Secretary of the Commission. His Royal Highness has expressed his wish that, as was the case in the International Health Exhibition last year, the exhibitors should themselves aid in the selection of jurors by submitting the names of those gentlemen whom they may consider most eligible. Exhibitors will, therefore, be asked to send in on a form, to be provided for the purpose, names of gentlemen who might be invited to serve as jurors. The actual selection of jurors will rest with the Jury Commission, who will endeavour to give full weight to the opinions expressed by exhibitors, but will not be restricted to the list of names suggested.

THE Tenth Report of the Boulder Committee of the Royal Society of Edinburgh has come to hand. It is the final report of the Committee appointed in 1871 to collect information regarding erratic blocks or boulders in Scotland, and the Committee do not expect that, by continuing inquiries on the lines available to them, much additional information of importance would be obtained. At all events they regard it as desirable now to arrange their information obtained during the past fourteen years in such a way as to make it more readily accessible. Accordingly they append an abstract of the information in the previous nine reports, so that the present volume may be regarded as a complete record of the work of the Committee. There is also added a "summary of facts, and of inferences apparently deducible from these facts, bearing on the question by what agency boulders were transported to their present sites." The suggested agency is that "of an oceanic current from some north-westerly quarter, bringing masses of floating ice, with boulders upon them, which boulders were deposited on our hills (then submarine) when the ice stranded on these hills." With regard to the question from what country these boulders could have come, and what could have produced the current, the Committee think that though answers might be suggested, they would be going beyond the objects of their appointment in doing so. Their proper province, they say, has been "simply to collect facts bearing on boulders in Scotland, embracing their distribution, their positions, and the agencies probably concerned in their transport. To explain the source or origin of their agencies, or, in other words, to unravel the conditions of the earth's previous history, so as to account for these agencies, is a problem the solution of which must be left to others."

A FULL Report on the East Anglian earthquake of April 22 last, which was probably the most destructive event of its kind in England within the historic period, will be read at the monthly meeting of the Essex Field Club on Saturday next. The Report has been very carefully prepared for the Council by Mr. R. Meldola, with the assistance of many members of the Club and

others. A collection of photographs showing the structural damage will be exhibited. The attendance of those interested in the subjected is invited.

THE last earthquakes in Southern Spain (February 15) were incident with slight subterranean motions in Algiers and in Savoy. The valley of Isère and Chambery principally felt them.

AN exceptionally severe shock of earthquake was felt at Geraldton in Western Australia on January 5. It was preceded by a subterranean rumbling lasting ten seconds. Houses were violently shaken, and the walls rocked, causing much consternation. The sea subsided three feet in a quarter of an hour, returning gradually to its ordinary level. The weather at the time was clear and the temperature cold.

MESSRS. SONNENSCHEIN AND CO. have published a third edition of Dr. Coppinger's "Cruise of the *Alert*."

WE have received from the Royal Museum of Anthropology of Leyden No. 1 of its "Anthropological Notices," by Drs. Serrurier and Jenkate. It deals with the Kroomen of Liberia, arranges the observations in them after the Broca-Topinard method. Only two individuals of the tribe, who had arrived as sailors on board a vessel at Rotterdam, were examined. They came from the region situated between Monrovia and the River Sesters. A plate containing an outline of the feet of each, and of the hand of one, is also added.

THE writer of the letter on "Human Hibernation" in NATURE of February 5 (p. 316) was Col. C. K. Bushe.

THE additions to the Zoological Society's Gardens during the past week include a Serval (*Felis serval* ♂), a Civet Cat (*Viverra civetta* ♀) from West Africa, presented by Mr. T. J. Alldridge, F.Z.S.; a Common Badger (*Meles taxus* ♀), British, presented by Mr. Cuthbert Johnson; two Common Foxes (*Canis vulpes* ♂ ♂), British, presented by Lady Brassey, F.Z.S.; two Pileated Jays (*Cyanocorax pileatus*) from Buenos Ayres, presented by Mr. Theo. Walsh; a Roseate Cockatoo (*Cacatua roseicapilla*) from Australia, deposited; two Malayan Squirrels (*Sciurus nigrovittatus*) from Malacca, a Four-horned Antelope (*Tetraceros quadricornis* ♀) from India, a Golden-winged Woodpecker (*Colaptes auratus*) from North America, a Pine Grosbeak (*Pinicola enucleator*), European, a Brazilian Teal (*Querquedula brasiliensis* ♀) from Brazil, purchased; four Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

THE DOUBLE-STAR PIAZZI XIV. 212.—Piazzi first remarked from his own observations between 1800 and 1809, the large proper motion of this star, which was determined by Argelander in vol. vii. of the Bonn Observations to be 2″·015 annually, in the direction 151°·2. "Der Begleiter 8·4m.," he adds, "theilt die Bewegung des Hauptstern; beide bilden also ein System, dass eine ziemlich rasche Aenderung der Distanz und des Positionswinkels zeigt. . . ." The following measures suffice to show the nature of the change in the relative position of the components:—

Herschel and South	1823·3	270°·2	10″·82
Burnham	1881·4	291°·3	15″·38

The most reliable measures may be closely represented by the formulæ—

$$D \cdot \sin P = -12''\cdot502 - [8\cdot78020] \cdot (t - 1850\cdot0)$$
$$D \cdot \cos P = +\ 2''\cdot613 + [8\cdot96275] \cdot (t - 1850\cdot0)$$

But there is one point of interest connected with this star to which attention seems hardly to have been directed—viz. the strange discordances in the estimates of the magnitudes of the components. To illustrate this we may quote the following from a much larger number of estimates recorded:—

At 6h. Greenwich Mean Time

		Star A	Star B
Herschel	1835·45	5½	7
,,	1837·46	6	9
Jacob	1856·24	6	7½
Argelander	1862·89	4·9	8·4
O. Stone	1877·37	7·0	8·5
Flammarion	1877·51	5·5	6·5
O. Stone	1879·47	5·0	8·0
Burnham	1880·32	6·0	8·0
O. Stone	1880·35	8·0	9·5
Burnham	1881·36	6·5	8·0

Gould has 6·3 and 7¼. The star is not in Argelander's *Uranometria*, nor has Heis got it. Argelander made a difference of 3½ magnitudes in 1862–63, Flammarion in 1877 rated the fainter star only one magnitude below the other. The difference between Burnham and O. Stone at nearly the same time in 1880 may have been due to atmospheric conditions at Cincinnati, but the star appears to be worth watching for variability; compare Argelander in 1862 with Burnham in 1881 or with Gould.

WOLF'S COMET.—The following ephemeris for 6h. G.M.T. is founded upon one for Berlin midnight, calculated from Prof. Krueger's last orbit, by Dr. Lamp, of Kiel:—

	R.A. h. m. s.	Decl. ° ′	Log. distance from Earth	Sun
March 2	3 7 13	−0 9·7	0·3243	0·2752
3	9 31	−0 2·6		
4	11 49	+0 4·4	0·3296	0·2776
5	14 7	0 11·3		
6	16 24	0 18·2	0·3348	0·2800
7	18 42	0 25·0		
8	20 59	0 31·8	0·3400	0·2825
9	23 16	0 38·5		
10	25 33	0 45·3	0·3451	0·2849
11	27 50	0 52·0		
12	30 6	0 58·6	0·3502	0·2873
13	32 22	1 5·1		
14	3 34 38	+1 11·6	0·3553	0·2897

Mr. J. I. Plummer observed the comet for position on February 18, notwithstanding the presence of a 3½ days' moon.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, MARCH 1–7

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 1

Sun rises, 6h. 47m.; souths, 12h. 12m. 27·8s.; sets, 17h. 39m.; decl. on meridian, 7° 24′ S.: Sidereal Time at Sunset, 4h. 18m.

Moon (Full at 4h.) rises, 17h. 12m.*; souths, 0h. 1m.; sets, 6h. 38m.; decl. on meridian, 6° 15′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on Meridian ° ′
Mercury	6 42	11 36	16 31	13 16 S.
Venus	6 23	11 12	16 2	14 19 S.
Mars	6 45	11 59	17 13	9 50 S.
Jupiter	16 19	23 29	6 39*	12 50 N.
Saturn	10 23	18 27	2 31*	21 38 N.

* Indicates that the rising is that of the preceding, and the setting that of the following nominal day.

Occultation of Star by the Moon

March	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
7	θ Libræ	4½	0 52	2 2	30 240

Phenomena of Jupiter's Satellites

March	h. m.		March	h. m.	
1	0 10	II. ecl. reap.	6	1 20	I. ecl. reap.
2	17 53	II. tr. egr.		4 5	II. tr. ing.
3	2 6	III. occ. disap.		19 19	III. tr. egr.
4	4 16	I. occ. disap.		20 0	I. tr. ing.
5	1 34	I. tr. ing.		22 20	I. tr. egr.
	3 54	I. tr. egr.	7	19 49	I. ecl. reap.
	22 42	I. occ. disap.		23 4	II. occ. disap.

The occultations of stars and phenomena of Jupiter's satellites are such as are visible at Greenwich.

Saturn, March 1.—Outer major axis of outer ring = 42″·3; outer minor axis of outer ring = 19″·2; southern surface visible.

March	h.	
6	10	Venus at greatest distance from the Sun.
7	14	Mercury in conjunction with and 1° 3′ south of Mars.

GEOGRAPHICAL NOTES

It is stated that the King of the Belgians is conferring with M. Martinie, president of the French Geographical Society, on the subject of the formation of an International Geographical Society.

The last issue of the *Izvestia* of the Eastern Siberian branch of the Russian Geographical Society contains an interesting paper by M. Doubrof on his journey to Mongolia. The author, accompanied by only one man, has explored the upper course of the Selenga and reached the hitherto unvisited source of this great tributary of Lake Baikal. Unhappily, on his return journey he was prevented from following the exploration of its middle course, the whole journey having been undertaken at so small an expense that the author had sharply to calculate every rouble he was able to expend. The want of barometrical observations on the high tablelands of the Upper Selenga is especially regretable, and it is not wholly compensated by a mere topographical description. A table of the times of the freezing of many Siberian rivers and of the breaking of the ice is given in the same fascicule, as also several notes on the Lena meteorological station—already old—and on the Yakutsk province.

The trade in children within the province of Yakutsk is the subject of an interesting note in the same journal. The Irkutsk Geographical Society had received a note from one of its members, who thus depicted the lot of girls within the province: In the last century the poorest Yakute who had no means of supporting a large family, took his new-born child in a covering of birch-bark and hung it on a tree in the forest to die from hunger. But the richer Russian merchants began to buy children from their poorer Yakute clients, and so several Russians purchased whole families of servants. This custom induced the Yakute communities to take care of the poorest children, and the community was bound to feed them, under the name of *Kumolan* children, who spent three days in the houses of the richer members of the community, two days in those of the moderately wealthy, and one day with the poorest. But of late the custom has arisen of selling children, and especially girls, to Olekminsk merchants, who sell them further to the Yakutes and Tunguses of the Olekminsk district. The parents sell girls for thirty to forty roubles (3*l.* to 4*l.*), and in Olekmir they are re-sold for sixty roubles, sometimes eighty roubles. Of course this trade is made under the cover of "taking children to bring up." The Irkutsk Society having taken interest in this communication, it has received information from Yakutsk authorities, and from a well-known student of Yakute life, M. Gorokhoff. It appears from these communications that such trade really exists, the chief impulse to it being given, less by the work a purchased girl might do than by the possibility of receiving for her the *kalym*, that is, the money paid by men for purchasing a wife. Woman labour is at so low a price that one might have a woman in his household and pay her half a piece of cotton, "for a shirt," per year. But the *kalym* reaches very high prices. One rich Yakute has recently sold his daughter to a Tungus for 3000 reindeer, and the same price was recently given by a half-idiotic Yakute for the daughter of another Yakute. Middendorff quotes also several instances of a very high *kalym* paid for girls, its average being about 500 roubles. When a Russian priest sold a girl whom he had educated for five sables and ten skins, it was considered as a very low price. Altogether, the *kalym* is the chief cause of maintaining the trade in girls, together with the gradual impoverishment of the Yakutes.

The *Japan Gazette* publishes a brief statement from Mr. Gowland, technical adviser to the Imperial Mint at Osaka, on his observations during a recent journey through part of Corea. He spent ten days at Seoul, the capital, and twenty days on the overland route between that place and the port of Fusan. He did not observe any indication of mineral wealth. There were no signs of mines, and nothing beyond doubtful indications of mineral veins in one or two places. There are no mountains exceeding about 4000 feet in highest elevation, and no characteristic volcanic cones. The central range was crossed by a pass 2300 feet above the sea-level. The forests were of no great extent, but very extensive tracts of cultivated ground, evidently yielding a large surplus production of rice, barley, and beans, were noticeable throughout. There was a marked absence of any manufacturing industry, or of indications that anything beyond food-products receives attention. The traffic on the roads was limited to that between neighbouring districts only, and this was very little. The beasts of burthen employed were rarely horses, frequently bullocks, and chiefly men. There is a total absence of any signs of wealth, and the resources of the country appear to lie solely in agriculture. There is no money, and no prospects of any foreign trade.

The last number of *Le Mouvement Géographique* has some interesting information about the celebrated first letter from Columbus. All interested in the early history of America know of the different editions of this letter, which was first published in 1493. Bibliographers mention seven of them: (1) one in Rome by Stephen Planck; (2) one called the Libri Lennox; (3) one in Rome by Eucharius Argenteus; (4) a second by Planck at Rome; (5) a Paris copy; (6) a second Paris copy; (7) one discovered in Turin by Harisse. To these an eighth has just been added by Ruelens, who discovered the only copy of it known to exist in the Royal Library at Brussels. It is a small pamphlet of four leaves in quarto, of thirty-eight lines, without figures or signature, in semi-Gothic characters. It appears to have been purchased between 1815 and 1830 by the Royal Library. Its title is: "Epistola Christophori Colom: cui etas nostra multum debet." The title then goes on as follows: "De Insulis Indie supra Gangem puper [for nuper] inventis. Ad quas perquirendas octavo ante mense auspiciis et ere inuictissimi Ferdinandi Hispaniorum Regis missus fuerat: ad magnificum Dominum Raphaelem Sauxis: ejusdem serenissimi Regis Tesaurarium missa: quam nobilis ac litteratus vir Aliander de Cosco ab Hispano idiomate in latinum convertit: tertio Maii MCCCC. XC. III. Pontificatus Alexandri Sixti Anno primo." Although the little pamphlet does not bear the name of a publisher, M. Ruelens, by comparing the works of the great Flemish printers, has discovered that Martens was the person. This individual distinguished himself among all his fellows about the end of the fifteenth century, at Antwerp, by his intelligent and progressive character. He was a great publisher of his day; he issued more than fifty writings of Erasmus, More's "Utopia," works of Savonarola, and many others. Facsimiles of the letter have been printed by M. Ruelens, and fifty of them, numbered and paged, are offered for sale. The discovery of this relic of geographical discovery, as well as of early Flemish printing, is an event of great interest.

The *Echo du Japan* reports the arrival in Japan, at the beginning of the year, of M. Joseph Martin, a French traveller, who has just been exploring the parts of Siberia hitherto very little known. His principal journey was from the Lena to the Amoor, across the Stanowai chain of mountains. During his explorations he was able to make geographical and geological collections, which are intended for the Paris museums. In consequence of hardships endured on the journey, two of his native followers died and one lost his reason.

In a paper read before the Statistical Society on the 17th inst. Sir Richard Temple endeavoured to check the various official returns of the population of China by applying the results obtained from the population statistics of British India. The various statements made by the Chinese Government as to the numbers of people under its rule show violent fluctuations, those of the last century and a half varying between 436 and 363 millions. These returns, as Prof. Douglas pointed out, varied with the purposes for which the enumerations were made. China proper and India, said Sir Richard Temple, are about the same area—a million and a half of square miles. Both countries are under similar conditions, physical, technical, climatic, geographical. In both there is a strong tendency to multiplication of the race. In both the population loved to congregate in favoured districts, to settle down and multiply there till the land could scarcely sustain the growing multitudes, and to leave the less favoured districts with a scanty though hardy population. The average population of the whole of India is 184 to the square mile, and if this average be applied to China (exclusive of the Central plateau) it gives a population of 282,191,600 souls. The writer then compared, one by one, the eighteen

provinces of China proper with the districts in India corresponding nearly in physical characteristics and cultivable area, and, summarising these computations, he found that, over a total area of 1,500,650 square miles, the population, according to this estimate from the Indian averages, would be 282,161,923, or, say, 183 persons to the square mile, while the latest official returns obtained from China show 349,885,386, or 227 inhabitants to the square mile. The general conclusion, he said, might be that the latest Chinese returns, though probably in excess of the reality, did not seem to be extravagant or incredible on the whole if tested by the known averages of the Indian census.

THE FORMS OF LEAVES[1]

SIR JOHN LUBBOCK said that, greatly as we all appreciated the exquisite loveliness of flowers, we must admit that the beauty of our woods and fields was as much due to the marvellous grace and infinite variety of foliage. How is this inexhaustible richness of forms to be accounted for? Does it result from an innate tendency of the leaves in each species to assume some particular shape? Has it been intentionally designed to delight the eyes of man? Or has it reference to the structure and organisation, the wants and requirements of the plant itself?

Now, if we consider first the size of the leaf, we shall find that it is regulated mainly with reference to the thickness of the stem. This was shown, for instance, by a table giving the leaf area and the diameter of stem of the hornbeam, beech, elm, lime, Spanish chestnut, ash, walnut, and horse-chestnut. When strict proportion is departed from, the difference can generally be accounted for.

The size once determined exercises much influence on the form. For instance, in the beech the leaf has an area of about 3 square inches. The distance between the buds is about $1\frac{1}{4}$ inches, and the leaves lie in the general plane of the branch, which bends slightly at each internode. The basal half of the leaf fits the swell of the twig, while the upper half follows the edge of the leaf above, and the form of the inner edge being thus determined decides that of the outer one also. In the lime the internodes are longer and the leaf consequently broader. In the Spanish chestnut the stem is nearly three times as stout as that of the beech, and consequently can carry a larger leaf surface. But the distances between the buds are often little greater than those in the beach. This determines, then, the width, and, by compelling the leaf to lengthen itself, leads to the peculiar form which it assumes. Moreover, not only do the leaves on a single twig admirably fit one another, but they are also adapted to the ramification of the twigs themselves, and thus avail themselves of the light and air, as we can see by the shade they cast without large interspaces or much overlapping.

In the sycamores, maples, and horse-chestnuts the arrangement is altogether different. The shoots are stiff and upright, with leaves placed at right angles to the plane of the branch, instead of being parallel to it. The leaves are in pairs, and decussate with one another, while the lower ones have long petioles, which bring them almost to the level of the upper pairs, the whole thus forming a beautiful dome.

For leaves arranged as in the beech, the gentle swell at the base is admirably suited; but in a crown of leaves, such as those of the sycamore, space would be thereby wasted, and it is better that they should expand at once, as soon as their stalks have carried them free from the upper and inner leaves. Hence we see how beautifully the whole form of these leaves is adapted to the mode of growth and arrangement, of the buds in the plants themselves.

In the black poplar the arrangement of the leaves is again quite different. The leaf-stalk is flattened, so that the leaves hang vertically. In connection with this it will be observed that, while in most leaves the upper and under surfaces are quite unlike, in the black poplar, on the contrary, they are very similar. The stomata or breathing-holes, moreover, which in the leaves of most trees are confined to the under surface, are in in this species nearly equally numerous on both. The "compass" plant of the American prairies, a yellow composite not unlike a small sunflower, is another plant with upright leaves, which, growing in the wide open prairies, tend to point north and south, thus exposing both surfaces equally to the light and heat. It was shown by diagrams that this position also affected the internal structure of the leaf.

In the yew the leaves are inserted close to one another, and are long and linear; while in the box they are further apart and broader. In the Scotch fir the leaves are linear, and $1\frac{1}{2}$ inch long; while in other pines, as, for instance, the Weymouth, the stem is thicker and the leaves longer.

In the plants hitherto mentioned one main consideration appears to be the securing of as much light as possible; but in tropical countries the sun is often too powerful, and the leaves, far from courting, avoid the light. The typical acacias have primate leaves, but in most Australian species the true leaves are replaced by a vertically flattened leaf-stalk. It will be found, however, that the seedlings have leaves of the form typical in the genus. Gradually, however, the leaf becomes smaller and smaller, until nothing is left but the flattened leaf-stalk or phyllode. In one species the plant throughout life produces both leaves and phyllodes, which give it a very curious and interesting appearance. In eucalyptus, again, the young plant has horizontal leaves, which in older ones are replaced by scimitar-shaped phyllodes. Hence the different appearances of the young and old trees which must have struck every visitor to Algiers or the Riviera.

We have hitherto been considering mainly deciduous trees. In evergreens the conditions are in many respects different. It is generally said that leaves drop off in the autumn because they die. This, however, is not strictly correct. The fall of the leaf is a vital process connected with a change in the cellular tissues at the base of the leaf-stalk. If the leaves are killed too soon they do not drop off. Sir John illustrated this by some twigs which he had purposely broken in the summer; below the fracture the leaves had been thrown off, above they still adhered, and so tightly that they could support a considerable weight. In evergreen trees the conditions are in many respects very different. It is generally supposed that the leaves last one complete year. Many of them, however, attain a much greater age: for instance, in the Scotch fir, three or four years; in the spruce and silver, six or seven; in the yew even longer. It follows from this that they require a tougher and more healthy texture. When we have an early fall of snow our deciduous trees are often much broken down; glossy leaves have a tendency to throw it off, and thus escape, hence evergreen leaves are very generally smooth and glossy. Again, evergreen leaves often have special protection either in an astringent or aromatic taste, which renders them more or less inedible; or by thorns and spines. Of this the holly is a familiar illustration; and it was pointed out that in old plants above the range of browsing quadrupeds, the leaves tend to lose their spines and become unarmed. The hairs on leaves are another form of protection; on herbs the presence of hairs is often associated with that of honey, as they protect the plants from the visits of creeping insects. Hence perhaps the tendency of water species to become glabrous, *Polygonum amphibium* being a very interesting case, since it is hairy when growing on land, and smooth when in water. Sir John then dealt with cases in which one species mimics another, and exhibited a striking photograph of a group of stinging nettles and dead nettles, which were so much alike as to be hardly distinguishable. No one can doubt that the stinging nettle is protected by its poisonous hairs, and it is equally clear that the innocuous dead nettle must profit by its similarity to its dangerous neighbour. Other similar cases were cited.

He had already suggested one consideration, which in certain cases determined the width of leaves; but there were others in which it was due to different causes, one being the attitude of the leaf itself. In many genera with broad and narrow-leaved species, drosera and plantago, for instance, the broad leaves formed a horizontal rosette, while the narrow ones were raised upwards. Fleshy leaves were principally found in hot and dry countries, where this peculiarity had the advantage of offering a smaller surface, and therefore exposing the plant less to the loss of water by evaporation.

Sir John then passed to aquatic plants, many of which have two kinds of leaves: one more or less rounded, which floats on the surface; and others cut up into narrow filaments, which remain below. The latter thus presents a greater extent of surface. In air, however, such leaves would be unable to support even their own weight, much less to resist any force such as that of the wind. In perfectly still air, however, for the same reason, finely divided leaves may be an advantage, whereas in

[1] Abstract by the Author of a Lecture delivered at the Royal Institute, Feb. 13 by Sir John Lubbock, Bart., M.P., D.C.L., LL.D., F.R.S., &c.

comparatively exposed situations more compact leaves may be more suitable. It was pointed out that finely cut leaves are common among low herbs, and that some families which among the low and herbaceous species have such leaves, in shrubby or ligneous ones have leaves more or less like those of the laurel or beech.

Much light is thrown on the subject by a study of the leaves of seedlings. Thus the furze has at first trifoliate leaves, which gradually pass into spines. This shows that the furze is descended from ancestors which had trifoliate leaves, as so many of its congeners have now. Similarly, in some species which when mature have palmate leaves, those of the seedling are heart-shaped. He thought that perhaps in all cases the palmate form was derived from the heart-shaped. He then pointed out that if there were some definite form told off for each species then a similar rule ought to hold good for each genus. The species of a genus might well differ more from one another than the varieties of any particular species; the generic type might be, so to say, less closely limited; but still there ought to be some type characteristic of the genus.

He took, then, one genus, that of Senecio (the groundsel). Now in addition to Senecios more or less resembling the common groundsel, there were species with leaves like the daisy, bushy species with leaves like rosemary and the box, small trees with leaves like the laurel and the poplar, climbing species like the convolvulus and bryony. In fact the list is a very long one, and shows that there is no definite type of leaf in the genus, but that the form in the various species depends on the condition of the species. From these and other considerations he concluded that the forms of leaves did not depend on any inherent tendency, but to the structure and organisation, the habits and requirements of the plant. Of course it might be that the present form had reference to former and not to present conditions. Nor did it follow that the adaptation need be perfect. The tendency existed, just as water tends to find its level. This rendered the problem all the more complex and difficult.

The lecture was illustrated by numerous diagrams and specimens, and Sir John concluded by saying the subject presented a wide and interesting field of study, for if he were correct in his contention every one of the almost infinite forms of leaves must have some cause and explanation.

SCIENTIFIC SERIALS

Journal of the Russian Chemical and Physical Society, vol. xvi. fasc. 8.—On the oxidation of acetones, by E. Wagner (first paper dealing with their behaviour towards chromic acid).—On the specific volumes of chlorine, iodine, and bromine in organic compounds, by M. Schalfejeff (second paper). For chlorine they gradually rise with the increase of the number of equivalents entering into combination, gradually reaching 21, 24, and 27; for bromine they are 24, 27, and 30; and for iodine, 26 to 27.—Addition of methylamine to methylglycidic acid, by M. Zelinsky.—On Astrakhanite, by W. Markovnikoff.—On the influence of the lineary compression of iron, steel, and nickel rods on their magnetism, by P. Bakmetieff. From a varied series of experiments the author arrives at a series of conclusions, showing that compression of iron rods exercises a very notable influence on their magnetisation, and that the phenomena depend upon the rods having been, or not, formerly submitted to repeated compression; all kinds of iron and steel display the influence of compression—soft iron and steel at a higher degree than hard iron and steel. The theory of rotating molecular magnets would explain all observed phenomena.—On an amperometre based on the electrothermic phenomenon of Pelletier, by N. Hesehus.—On the regular forms taken by powders, by Th. Petrushevsky (second paper dealing with the shapes taken by heaps of powders on surfaces limited by curves, or polygones with entering angles).—Also on the dilatation of liquids; an answer to Prof. Arenarius, by D. Mendeleeff.—An answer to M. Rogovsky, by B. Stankewitsch.—An answer to M. Sokoloff, by M. Bardsky, being a further mathematical inquiry into the forces of molecular attraction.—An answer to M. Petroff, by M. Kraevitsch.—We notice an innovation in this fasciculum of the *Journal*. It contains detailed minutes of the proceedings of the Physical and Chemical Section of the Moscow Society of Lovers of Natural Science.

Sitzungsberichte der Physicalisch-medicinishen Societät zu Erlangen, No. 16, October, 1883, to October, 1884.—Remarks on the phenomenon of phosphorescence in connection with the description of an instrument designed for studying the effect of the various spectral rays, and especially the ultra-red on phosphorising substances, by E. Lommel.—On the fluorescence of calcspar, by E. Lommel.—On the reduction of algebraic differential expressions to normal forms, by M. Noether.—Contributions to the knowledge of the Chytridiaceæ and other fungoid organisms, with thirty-seven illustrations, by D. C. Fisch.—On the malaria and intermittent fevers of the Erlangen district, by Prof. F. Penzoldt.—On the presence of microscopic organisms in the tissues of animals in the normal state, by Dr. Hauser.—Test of the sensitiveness of the visual organ to direct and oblique luminous rays, by Dr. Louis Wolfiberg.—On algebraic differential expressions, and on Jacobi's reverse problem, by M. Noether.—On the systematic position of the yeast fungus, by M. Reess.—On two new species of Chytridiaceæ, by C. Fisch.—On the nerves of temperature and touch in the animal system, by J. Rosenthal.—On a means of determining the quantity of carbonic acid present in the atmosphere of rooms, by J. Rosenthal.—On the phenomenon of Uræmia, by Dr. R. Fleischer.—Toxicologic researches from the physiological standpoint, by J. Rosenthal.—On vertigo caused by intestinal affections, by W. Leube.—Experiments on the hatching of bird's eggs whose shells had suffered lesion, by Prof. L. Gerlach.—On Oidema, by Dr. R. Fleischer.—On the surgical operation of opening the mastoid process, by Dr. W. Kiesselbach.—On the life-history and pathological properties of a species of bacteria causing putrefaction, by Dr. G. Hauser.—On the histiology of primary carcinom in the osseous system, by Dr. von Düring.—On a case of lingual tuberculosis, by Dr. Ernst Graser.—On the after-treatment of external urethrotomy, by H. Knoch.

Rivista Scientifico-Industriale, December 31, 1884.—On the electric conductivity of the alcoholic solutions of some chlorides, by Dr. Joseph Vicentini.—Memoir on the variations in the electric resistance of solid and pure metal wires according to the temperature (continued), by Prof. Angelo Euro.

SOCIETIES AND ACADEMIES

London

Royal Society, February 12.—"On Underground Temperatures, with Observations on the Conductivity of Rocks, on the Thermal Effects of Saturation and Imbibition, and on a Special Source of Heat in Mountain Ranges." By Joseph Prestwich, M.A., F.R.S., Professor of Geology in the University of Oxford.

The author remarks on the difference of opinion between physicists and geologists respecting the probable thickness of the outer crust of the earth—the former on the strength of its great rigidity and the absence of tides, contending for a maximum thickness and comparative solidity of the whole mass; while the latter, in general, on the evidence of volcanic action, the crumpling and folding of the strata in mountain ranges, its general flexibility down to the most recent geological times, and the rate of increase of temperature in descending beneath the surface, contend for a crust of minimum thickness as alone compatible with these phenomena.

The question of underground temperature, which is a subject equally affecting the argument on both sides, had engaged the author's attention in connection with an inquiry respecting volcanic action, and he was induced to tabulate the results to see how far the usually received rates of increase were affected by various interfering causes—not that most of them had not received due attention, but it was a question whether sufficient allowance had been made for them.

Although Gensanne's first experiments were made in 1740, and others were subsequently made by Daubuisson, Saussure, and Cordier, in coal and other mines, it was not until the construction of deep artesian wells commenced in the second quarter of this century, and Walferdin introduced his overflow thermometer, and precautions were taken against pressure, that the more reliable observations were made and admirably discussed by Arago. The Coal Commission of 1866 collected a mass of important evidence bearing on the question, and in 1867 a Committee of the British Association was appointed to collect further information. Under the able superintendence of Prof. Everett, a series of valuable experiments with improved instruments has

been made, and full particulars published in the *Annual Reports* of 1868-83.

But notwithstanding the precautions taken, and the accuracy of the experiments, they present very wide differences in the thermometric gradient, ranging from under 30 to above 120 feet per degree F. Consequently different writers have adopted different mean values. On the Continent one of 30 m. per degree C. has been commonly adopted, while in this country some writers have taken a mean of 50 feet per degree, and others of 60 feet or more. The object which the author has in view is to see whether it is not possible to eliminate the more doubtful instances, and to bring the probable true normal gradient within narrower limits. In so doing he confines himself solely to the geological side of the inquiry.

In a general list, Table I., he gives all the recorded observations in the order of date. The list embraces observations at 530 stations in 248 localities. The most reliable of these he classifies under three heads in Tables II., III., and IV.

(1) Coal mines.
(2) Mines other than coal.
(3) Artesian wells and bore-holes.

To which tunnels are added in a supplement.

The author then proceeds to point out that the gradients given in many of the earlier observations were wrong in consequence of neglecting the height of the surface, and from the exact mean annual temperature of the locality not being known. They also differed amongst them elves from taking different surface temperatures, and starting from different datum levels. To these he endeavours to assign a uniform value.

The essential differences in the results in several tables depend, however, upon dissimilar geological conditions, which unequally affect the conductivity of the strata, and disturbing causes of different orders. In the mines the latter are :—

(1) The currents established by ventilation and convection.
(2) The circulation of underground waters.
(3) Chemical reactions.
(4) The working operations.

And in artesian wells—

(1) The pressure of the water on the thermometers.
(2) Convection currents in the column of water.

In the latter experiments pressure has been thoroughly guarded against, but against the subtle influence of the other causes, though long known, it is more difficult to guard.

Coal Mines.—The author then proceeds *seriatim* with each subject, commencing with coal-mines. In these he shows that ventilation and convection currents have rendered many of the results unreliable, as he shows to have been the case in the well-known instance of the Dukinfield coal pit. The circulation of air in coal pits varies from 5000 to 150,000 cubic feet per minute, and tables are given to show how this variously affects the temperature of the coal at different distances from the shaft, *though on the same level*. As a rule, the deeper the pit the more active is the ventilation, and therefore the more rapid the cooling of the underground strata. In some pits the indraughted air has been known to form ice, not only in the shaft, but icicles in the mine near the shaft.

The cooling effects of ventilation are shown to begin immediately that the faces of the rock and coal are exposed, and as the hotter (and deeper) the pit, and the more gassy the coal, the more active is the ventilation, so these surfaces rapidly undergo a cooling until an equilibrium is established between the normal underground temperature and the temperature of the air in the gallery. Judging by the effects of the diurnal variations on the surface of the ground, it is clear that an exposure of a few days must, when there is a difference of 10° to 12° or more between the air in the gallery and the normal temperature of the rock, tell on the exposed coal and rock to the depth of 3 to 4 feet —the usual depth of the holes in which the thermometers are placed. The designation of "fresh open faces" is no security, as that may mean a day or a week, or more. The author considers also that so far from the length and permanence of the experiment affording security, he is satisfied on the contrary that those experiments in which it is stated that the thermometer has been left in the rock for a period of a week, a month, or two years without any change of temperature, affords *prima facie* evidence of error, inasmuch as it shows that the rock has so far lost heat as to remain in a state of equilibrium with the air at the lower temperature in constant circulation.

Another cause of the loss of heat which requires some notice is the escape of the gas, which exists in the coal either in a highly compressed, or, as the author thinks more probable, in a liquid state. A strong blower of gas has been observed to render the coal sensibly cooler to the touch. In another case whereas the temperature of the coal at the depth of 1269 feet was 74° F., at the greater depth of 1588 feet in a hole with a blower of gas it was only 62°. One witness observed that "the coal gives out heat quicker than the rock." There is generally a difference of 2° or 3° between them.

On the other hand, the coal and rocks when crushed and in "creeps" acquire a higher temperature owing to the liberation of heat.

The effects of irregularities of the surface on the underground isotherms, although unimportant in many of our coal-fields, produce very decided results in the observations on the same level in the mines among the hills of South Wales. Sections are given to show how the temperature rises under hills and falls under valleys, showing that it is often essential to know not only the depth of the shaft but the depth beneath the surface at each station where the experiments are made.

The author therefore considers that to assign a value to an observation we should know (1) height of pit above sea-level ; (2) the exact mean annual temperature of the place ; (3) depth beneath the surface of each station ; (4) distance of the stations from the shaft ; (5) temperature and columns of air in circulation ; (6) length of exposure of face ; (7) whether or not the coal is gassy. The dip of the strata and the quantity of water are also to be noted.

Very few of the recorded observations come up to this standard, and the author has felt himself obliged to make a very restricted selection of cases on which to establish the probable thermometric gradient for the coal strata. Amongst the best observations are those made at Boldon, North Seaton, South Hetton, Rosebridge, Wakefield, Liége, and Mons. These give a mean gradient of 49½ feet for each degree F. The bore-holes at Blythswood, South Balgray, and Creuzot give a mean of 50·8 feet.

Mines other than Coal.—The causes affecting the thermal conditions of these mines are on the whole very different to those which obtain in coal mines. Ventilation affects both, but in very unequal degrees. In mineral mines it is much less active, and the cooling effects are proportionately less. On the other hand the loss of heat by the underground waters in mineral mines is very important. In some mines in Cornwall, the quantity of water pumped up does not exceed 5 gallons, while in others it amounts to 200 gallons per minute. The Dolcoath mine used to furnish half a million gallons of water in the twenty-four hours, while at the Huel Abraham mine it reached the large quantity of above 2,000,000 gallons daily. The rainfall in Cornwall is about 46 inches annually, and of this about 9 inches pass underground. In the Gwennap district, where 5500 acres were combined for drainage purposes, above 20,000,000 gallons have been discharged in the twenty-four hours from a depth of 1200 feet. This water issues at temperatures of from 60° to 68°, or more than 12° above the mean of the climate, showing how large must be the abstraction of heat from the rocks through which the waters percolate.

Hot springs are not uncommon in these mines. They are due to chemical decomposition, and to water rising in the lodes and fissures from greater depths. The decomposition which goes on in the lodes near the surface, and whereby the sulphides of iron and copper are reduced ultimately to the state of peroxides and carbonates of those metals, is a permanent cause of heat, especially apparent in the shallower mines. On the other hand, where the surface waters pass rapidly through the rocks, they lower the temperature and give too low readings.

While ventilation, therefore, reduces the rock temperature, the water which percolates through the rock, and more especially through the veins and cross-courses, sometimes raise, and at other times lower, the temperature of the underground springs. Mr. Were Fox, who for many years made observations on the underground temperature of the Cornish mines, gave the preference to the rocks ; while Mr. Henwood, an observer equally experienced and assiduous, considered that the underground springs gave surer results. Both were of course fully alive to all the precautions that in either case it was necessary to take to guard against these interferences.

Taking ten of the most reliable of Mr. Henwood's observations at depths of from 800 to 2000 feet, the mean gives a thermometric gradient of 42·4 feet per degree, but Mr. Henwood himself gives us the mean of 134 observations to the depth of

1200 feet, a gradient of 41·5 feet to the experiments in granite, and of 39 feet to those in slate.

Taking the experiments of Mr. Fox in eight mines, varying in depth from 1100 to 2100 feet, the mean of the experiments made in the rock gave a gradient of 43·6 feet per degree, or for the mean of the two observers we have a gradient of 43 feet per degree.

For the foreign mines, in the absence of fuller data, and especially failing in information of the depth of the station beneath the surface, which in the hilly district of Freiberg and Hungary introduces an element of great uncertainty, it is impossible to arrive at any safe conclusion.

Artesian Wells and Borings.—This class of observations presents results much more uniform, and whereas the mines observations were made, the one in crystalline, and the other in unaltered Palæozoic rocks, the wells are, with few exceptions, either in the softer and less coherent rocks of Cretaceous, Jurassic, and Triassic age, which are much more permeable, and, as a rule, much less disturbed.

The causes of interference are mainly reduced to pressure on the instruments and convection currents. The early experiments, where no precautions were taken against these, are, with few exceptions, unreliable, and must be rejected. The larger the bore-hole, the greater the risk of convection-currents, and Prof. Everett has shown that in many cases of deep and large artesian borings, the water which lodges in them is reduced to a nearly uniform temperature throughout the whole depth by the action of these currents. In the deep boring at Sperenberg, before the introduction of plugs to stop these currents, it was found that the temperature near the top of the bore was rendered 4°·5 F. too high, and at the bottom, at a depth of 3390 feet, 4°·6, if not 6°·7, too high by the currents.

Taking the bore-holes in which the water does not overflow, and where, owing to the precautions against these sources, such as those of Kentish Town, Richmond, Grenelle, Sperenberg, Pregny, and Ostend, we get a mean gradient of 51·9 feet per degree.

Overflowing artesian wells should, if we were sure of all the conditions, give the best and most certain results. Taking those where the volume of water is large, and the observations made by competent observers, as in the case of the wells of Grenelle, Tours, Rochefort, Mondorff, Minden, and others, we obtain a mean of 50·2 feet, or, taking the two sets of wells, of 51 feet per degree.

The author, however, points out a source of possible error in those wells, arising from a peculiarity of tubage which requires investigation, and owing to which he thinks the water may suffer a loss of heat in ascending to the surface.

With respect to the extra-European wells, more particulars are required. It may be observed, however, that the wells in the Sahara Desert, which were made by an experienced engineer accustomed to such observations, the mean of eleven overflowing wells, at depths of from 200 to 400 feet, gave 36 feet per degree.

Tunnels.—For the Mont Cenis Tunnel, allowing for the convexity of the surface, Prof. Everett estimates the gradient at 79 feet, and for the St. Gothard, 82 feet per degree. But Dr. Stapff found in the granite at the north end of the tunnel a much greater heat and more rapid gradient, for which there seemed no obvious explanation. Though this axis of the Alps is of late Tertiary date, the author points out that it cannot be due to the protrusion of the granite, as the Swiss geologists have shown that the granite was in its present relative position and solidified before the elevation of this last main axis of the Alps, and he suggests that the higher temperature may be a residue of the heat caused by the intense lateral pressure and crushing of the rocks which accompanied that elevation, for in the crushing of a rigid material such as rock almost the entire mechanical work reappears as heat.

Conductivity of the Rocks. Effects of Saturation and Imbibition.—Some of the apparent discrepancies in the thermometric gradients are no doubt due to differences in the conductivity of the rocks. Applying the valuable determinations of Profs. Herschel and Lebour to the groups of strata characterising the several classes of observations, the following results are obtained :—

	Mean conductivity k	Mean resistance r
(1) Carboniferous strata	·00488 ...	275
(2) Crystalline and schistose rocks ...	·00546 ...	184
(3) Triassic and Cretaceous strata ...	·00235 ...	465

From this it would appear that the conductivity of the rocks associated with the mineral mines is twice as great as that of the artesian wells class. But all the experiments, with the exception of three or four, were made with blocks of dried rocks, and those showed a very remarkable difference ; thus, for example, dry New Red Sandstone gave k0·00250, whereas when wet it was increased to k0·00600. The author remarks that as all rocks below the level of the sea and that of the river valleys are permanently saturated with water, dry rocks are the exception and wet rocks the rule in nature, consequently the inequalities of conductivity must tend to disappear. The power of conduction is also greater along the planes of cleavage or lamination than across them, and therefore the dip of the strata must also exercise some influence on the conductivity of different rocks and "massifs." With respect to the foliated and schistose rocks, M. Jannettaz has shown that the axes of the thermic curve along and across the planes of foliation and cleavage are in the following proportions :—

Gneiss of St. Gothard	1 : 1·50
Schists of Col Voza...	1 : 1·80
Cambrian slates, Belgium	1 : 1·98

This cause will locally affect the rock masses.

Conclusion.—The author deduces from the three classes of observations a general mean thermic gradient of 48 feet per degree F., but he considers this only an approximation to the true normal gradient, and that the readings of the coal-mines and artesian-well experiments are, owing to the causes he enumerates, still too high. He also discusses the question whether or not the gradient changes with the depth. His own reduction of the observations gave no result, but he points out that in all probability the circulation of water arising from the extreme tension of its vapour is stayed at a certain depth ; while it has been shown experimentally that the conductivity of iron diminishes rapidly as the temperature increases, and this may possibly in a different degree apply to rocks. If, therefore, there is any change, these indications would be in favour of a more rapid gradient.

Taking all these conditions into consideration, the author inquires whether a gradient of 45 feet per degree would not be nearer the true normal than even the one of 48 feet obtained by the observations.

Linnean Society, February 19.—Prof. P. Martin Duncan, F.R.S., Vice-President, in the chair.—The Rev. L. Martial Klein was elected a Fellow.—Mr. Thiselton Dyer exhibited and made remarks on specimens of the peculiar Chinese "square bamboo" (*Bambusa quadrangularis*, Fenzi), and of articles made from the so-called "hairy bamboo" (probably *Dendrocalamus latiflorus*, Munro), sent from Wenchow to the Kew Museum by Dr. Macgowan.—Mr. T. Christy afterwards drew attention to silk fibres received from Auckland, New Zealand.—An abstract of Part iii. of the Rev. A. Eaton's monograph on the Mayflies (Ephemeridæ) was read by the Secretary. In this, the fourth series of group 2 of the genera are dealt with. Among representatives of Section 9, *Cloën* is distinguished by absence of hind wings, *Callibætis* by costal projection and cross-veinlets of its broad obtuse hind wings, *Baetis* by small or absence of costal projection and deficiency of cross veinlets, and *Centroptilum* by extreme narrowness of hind wings and slenderness of costal projection. The distinctive characteristics of sections 10 and 11 of the genera are also taken into consideration, and full descriptions of many new species given.—Then followed notes on the European and North American mosses of the genus *Fissidens*, by Mr. W. Mitten. Referring to the more recent important contributions of Dr. Braithwaite's British Moss-Flora, and Messrs. Lesquereux and James's North American Mosses, and taking into account definitions of older writers, such as Dillenius, Hedwig, Swartz, and others, Mr. Mitten endeavours to arrange the entire group afresh, partly in a tabular form, and afterwards supplementing this by notes on the individual species.—A paper was read by Prof. P. M. Duncan on the anatomy of the Ambulacra of the recent Diadematidæ. The author described the arrangement of the compound plates of the genera of *Diadema*, *Echinothrix*, *Centrostephanus*, *Atropyga*, *Micropyga*, and *Aspidadiadema*. The first three genera have triplets, consisting of primaries, the adoral and aboral plates being low and broad, and the second, or central plate, being a large primary. Nea, the peristome there is deformity of this typical arrangement and in *Echinothrix* a demiplate may enter, but it is never the second plate. In *Astropyga* the triplets are arranged so that the

majority are on the *Diadema*-type, and the exceptions were recorded. The structure of the triplets of *Micropyga* is unique, and the arrangements, leaving out the position of the pores, is somewhat like that of *Cœlopleurus*. *Aspidodiadema*, as has been explained by A. Agassiz, is like *Cidaris* in its ambulacra.

Mathematical Society, February 12.—J. W. L. Glaisher, F.R.S., President, in the chair.—Miss Emily Perrin, Ladies College, Cheltenham, was elected a Member, and Mr. J. Griffiths was admitted into the Society.—Mr. Tucker read the following papers:—"Sur les Figures semblablement Variables," by Prof. J. Neuberg; on the extension of Ivory's and Jacobi's distance-correspondences for quadric surfaces, by Prof. J. Larmor; and some properties of a quadrilateral in a circle the rectangles under whose opposite sides are equal, by R. Tucker. Messrs. Jenkins and S. Roberts spoke on the subject of the first paper. A clear idea of Mr. Tucker's communication will be obtained by drawing a figure for the following particular case:—Take a quadrilateral, $ABCD$, in a circle, with its angles A, $B = 58°$, $112°$ respectively, and AB (the unit of length) equal the side (in this case) of the inscribed square. Let $BC = \lambda$, $CD = \mu$, $DA = \nu$; then if two sets of lines drawn in the same *senses* with the respective sides from the two ends make with those sides (in the particular case) angles of 38°, these lines will intersect in two sets of 4 lines in P, P' (analogous to the Brocard points of a triangle), and in four sets of 2 lines in F, G, H, K. The quantities λ, μ, ν, are so related that $\lambda\nu = \mu$, hence we see that all such quadrilaterals have the rectangles under their opposite sides equal. The six points lie on a circle which also passes through the circum-centre (O), point of intersection (E) of the diagonals AC, BD, and through the mid-points M, L of those diagonals. In fact, since OE is a diameter of this new circle, the mid-points of any chord of the circum-circle which passes through E lies on the small circle. P, P' are the foci of an ellipse inscribed in $ABCD$. Further properties are $OP = OP'$, $AP \cdot BP \cdot CP \cdot DP = AP' \cdot BP' \cdot CP' \cdot DP'$, and many other metrical and angular relations belong to the above collection of points. If instead of 38° we take ϕ, then ϕ is found by the equation $\operatorname{cosec}^2\phi = \operatorname{cosec}^2 A + \operatorname{cosec}^2 B$. The side AB subtends at an opposite vertex an $\angle\,\theta_1$, such that $\cot\theta_1 = \cot\phi - \cot A - \cot B$, with similar values for the other angles. The circum-radius (R) is found by—

$$2R^2 = (\cot\phi - \cot A)(\cot\phi - \cot B),$$

and that of the small circle (ρ) by

$$2\rho = R \sec\phi \sqrt{\cos 2\phi}.$$

Relations connecting the θ set and ϕ with the Brocard angles of the 4 constituent-triangles are easily obtained in a neat form. If through E lines are drawn parallel to the sides cutting them in eight points, these points lie on a circumference which has many properties analogous to those of the "$T.R.$" circle of a triangle. If ρ' is its radius, then $\rho^2 + \rho'^2 = R^2/_2$: the eight points from two equal inscribed quadilaterals similar to the given figure, and whose sides make the same angle ϕ with the given sides.

Geological Society, January 28.—Prof. T. G. Bonney, F.R.S., President, in the chair.—Frederick John Cullis, Henry Dewes, Henry Hutchings French, Jacob Hort Player, and the Hon. Donald A. Smith, were elected Fellows, and Prof. F. Fouqué, of Paris, and Dr. Gustav Lindström, of Stockholm, Foreign Correspondents of the Society.—The President called attention to the great loss the Society had sustained in the sudden and unexpected death of Dr. J. Gwyn Jeffreys, F.R.S., &c., who had been for twenty-one years continuously a Member of the Council, and for fourteen years of that time had performed most valuable services to the Society as Treasurer.—The following communications were read:—The Boulder Clays of Lincolnshire: their geographical range and relative age, by A. J. Jukes-Browne, F.G.S. The author commenced by referring to the late Mr. Searles V. Wood's papers on the glacial beds of Yorkshire and Lincolnshire, and stated, as the result of his own investigations, that two distinct types of boulder clay occur in Lincolnshire: (1) the gray or blue clay; (2) the red and brown clays, the former undoubtedly an extension of the upper or chalky boulder clay of Rutland and East Anglia, while the second includes the purple and Hessle clays of Mr. S. V. Wood. These two types of boulder clay are very rarely in contact with each other. The brown boulder clays of East Lincolnshire rest upon a broad plain of chalk, which appears to terminate westward in a concealed line of cliff, this cliff-line coinciding with the strike of the slope which descends from the chalk wolds to the boulder clay plateau by which they are bordered. The present boundary line of the boulder clay runs along this slope for long distances, though in many places the clay has surmounted the slope and caps the hills to the west of it. From Louth the main mass of the "brown clay" is bounded by a line drawn through Wyham, Hawerby, Laceby, and Brocklesby to Barrow and Barton on Humber, sweeping around the north end of the Lincolnshire wolds and occurring on both sides of the Humber. Previously to the author's inspection of this district no purple or Hessle clay had been discovered west of South Ferriby, and these clays were suppo ed to be entirely absent on the western side of the wolds. The officers of the Survey have, however, mapped several tracts of such clay in the valley of Ancholme. It occupies the surface at Horkstow, Winterton Holme, Winterton, and Winteringham. It probably underlies the alluvium of the Ancholme near and south of these places, and occurs again at higher levels in the neighbourhood of Brigg. South of Brigg it has been seen at low levels on either side of the valley of the Ancholme, as far as Bishop's Bridge near Glentham. Beyond this point it was not traceable in the Ancholme valley, but south of Market Rasen patches of reddish-brown clay, mottled with gray, and containing small flints and pebbles of chalk, occur, and cap the low ridges separating the valleys of the brooks. Another tract of boulder clay, which the author considers to belong to the same series, occupies the western border of the fenland south-east of Lincoln, what is left of it forming a ridge which runs southward for many miles. It passes eastward beneath the fen deposits; and similar mottled clay was seen in the excavations for the Boston Docks beneath about twenty feet of fen clays, &c., and resting upon blue boulder clay of the "chalky" type. Besides this section at Boston, there are very few places where the two types of clay are in contact, or so near as to afford any evidence as to their relative age. Near East and West Real, and again near Louth, the "brown clays" are banked against the slopes of hills which are capped with the "chalky clay." The same is the case also near Brigg, where the country seems to have been originally covered by a sheet of the chalky clay, through which valleys were eroded into the Jurassic clays, and the brown (Hessle) clay is found only in these valleys. The author concludes, therefore, that the "Brown-clay series" is of much newer date than the "Blue and Grey series." In conclusion the author summed up the inferences drawn in the paper, correlated the Basement clay of Holderness with the Chalky clay of Lincolnshire, and suggested that the Purple clay may be confined to the east side of the wolds. The classification he would propose is therefore as follows:—

	Lincolnshire.	Yorkshire.
Newer Glacial.	Hessle clay.	Hessle and upper red clay of coast.
	Purple clay.	Purple clay.
Older Glacial =	Chalky clay.	Basement clay.

—On the geology of the Rio Tinto Mines, with some general remarks on the pyritic region of the Sierra Morena, by J. H. Collins, F.G.S. After briefly describing the geographical position of the Rio Tinto mines and the occurrence at the same of pyritous ores amongst slates and schists which abut against gneissose rocks to the north, and pass under Tertiary beds to the southward, the author proceeded to consider the general characters and associations of the pyrites-deposits, and then gave a general account of the Rio Tinto district. The slates were described, and the fossil evidence recapitulated upon which an Upper Devonian age had been assigned to them. Analyses were furnished to show the changes due to weathering and to infiltration. The various intrusive rocks (syenite, diabase, and porphyries) occurring in the schists were described, and analyses of them given. The sedimentary iron ores and their composition were next noticed, and the author ascribed their formation to deposition in lakes. The masses of pyrites which furnish the principal ores of Rio Tinto were then described, their mode of occurrence in fissures between dissimilar rocks explained, and their formation discussed. The different kinds of ore obtained from the mines were noticed in detail, and several analyses added, giving samples both of the mixed ores and of the pure minerals. The manganese lodes were next described, and shown to be parallel to the pyrites fissures, and frequently to be only branches of the latter. A summary of the author's conclusions as to the stratigraphy of the district, the ore deposits, and the surface-geology was appended.—On some new or imperfectly known Madreporia from the Great Oolite of the counties of Oxford, Gloucester, and Somerset, by R. F. Tomes, F.G.S.

Physical Society, February 14.—Annual General Meeting.—Prof. Guthrie, President, in the chair.—Prof. G. Fuller was elected a Member of the Society.—The President then read the Report of the Council, in which the Society was congratulated upon the number of original communications read—forty-three during the past year. Among the works undertaken by the Society may be mentioned the publication of the first volume of "Joule's Scientific Works"; a second volume, containing accounts of researches conducted by Mr. Joule in conjunction with other scientific men, would be published shortly.—The Treasurer presented a highly satisfactory report.—The Council for the ensuing year was then elected, the result of the election being as follows:—President: Prof. F. Guthrie, Ph.D., F.R.S.; Vice-Presidents (who have filled the office of President): Dr. J. H. Gladstone, Prof. G. C. Foster, Prof. W. G. Adams, Sir W. Thomson, Prof. R. B. Clifton; Vice-Presidents: Prof. W. E. Ayrton, Shelford Bidwell, Lord Rayleigh, Prof. W. C. Roberts; Secretaries: Prof. A. W. Reinold and Walter Baily; Treasurer: Dr. E. Atkinson; Demonstrator: Prof. F. Guthrie; other Members of Council: C. Vernon Boys, C. W. Cooke, Prof. G. Forbes, Prof. F. Fuller, R. T. Glazebrook, Dr. J. Hopkinson, Prof. H. McCleod, Prof. J. Perry, Prof. J. H Poynting, Prof. S. P. Thompson; Honorary Member: Prof. M. E. Mascart.—The customary votes of thanks to the Committee of the Council of Education and to the President, Secretaries, and other officers having been passed, the meeting resolved itself into an ordinary meeting of the Society.—Miss Marks described a new line and area divider. This instrument consists of a hinged rule with a firm joint. The inside edge of each limb is bevelled, and presents a straight edge. One limb is divided on both edges into a number of equal parts, and is fitted by a groove on its outer edge to a plain rule, along which it can slide. To divide a line into a given number of equal parts, the hinged rule is slid along the plain rule till the *n*th division from the joint is opposite a fixed mark on the plain rule; it is then placed on the paper so that the *n*th division on the graduated straight edge coincides with one end of the given line, and then opened till the straight edge on the inner edge of the other limb passes through the other extremity. The plain rule is then pressed firmly down and the hinged rule slid along it. As each division of the graduated edge passes the fixed mark, the intersection of the moving edge with the given line is marked, and thus the line is divided into *n* equal parts. The instrument may be used in this way to draw any given number of equidistant parallel lines between two given points. It may be conveniently used in working out indicator diagrams and measuring areas.—Mr. Walter Baily described certain improvements made in his integrating anemometer, which has been previously described. The improvements consist in the substitution of mechanical counters for electrical ones, as it was found, in the recent observations with the instrument at Kew, that the extra friction of the "contact" was sometimes sufficient to stop the motion. The mechanical counters were found to work satisfactorily in every respect.—Prof. Guthrie showed some specimens exhibiting the similarity of fracture of Canada balsam and glass. The glass had been cracked by heating a metal ring to which it was attached; the Canada balsam had been overheated in a small dish and allowed to cool.

Zoological Society, February 17.—Osbert Salvin, F.R.S., Vice-President, in the chair.—Mr. F. E. Beddard, F.Z.S., read a paper upon the structure of the Cuckoos (Cuculidæ), and pointed out the differences in the pterylosis and the structure of the syrinx in the various forms which he had examined. It was proposed to divide the family into three sub-families: Cuculinæ, Phœnicophainæ, and Centropodinæ.—Mr. F. E. Beddard read a paper upon the heart of *Apteryx*, and called attention to the variations in the condition of the right auriculo-ventricular valve observed in different individuals of this bird.—A communication was read from Mr. M. Jacoby, containing the first part of an account of the Phytophagous Coleoptera obtained by Mr. George Lewis during his second journey in Japan, from February, 1880, to September, 1881.

Geologists' Association, February 6.—W. H. Hudleston, F.R.S., in the chair.—The annual meeting was held at University College.—The following Officers were elected for the ensuing year:—President: W. Topley, F.G.S., Assoc.Inst.C.E.; Vice-Presidents: Prof. J. F. Blake, M.A., F.G.S., T. V. Holmes, F.G.S., W. H. Hudleston, F.R.S., F.G.S., F.C.S., Henry Hicks, M.D., M.R.C.S., F.G.S.; Treasurer: J. Hopkinson, F.G.S., F.L.S.; Secretary: John Foulerton, M.D., F.G.S.; Editor: Prof. G. S. Boulger, F.L.S., F.G.S.; Librarian: J. Bradford, F.G.S.; Council: J. Logan Lobley, F.G.S., F.R.G.S., Ed. Litchfield, A. C. Maybury, F.G.S., J. Love, F.G.S., F.R.A.S., W. H. Bartlett, F.G.S., T. Davis, F.G.S., J. J. H. Teall, F.G.S., R. Meldola, F.C.S., J. Slade, F.G.S., J. S. Gardner, F.G.S., Prof. T. Rupert Jones, F.R.S., B. B. Woodward, F.G.S.—Prof. T. R. Jones, F.R.S., gave an address on Foraminifera, recent and fossil, and Mr. F. W. Rudler one on some points in connection with volcanic action; both were illustrated by lantern views exhibited by Mr. G. Smith.—Many instructive objects were exhibited, amongst them a series of Palæolithic implements from France, Spain, and England, by Dr. J. Evans, F.R.S.

EDINBURGH

Royal Society, February 2.—Mr. Thomas Stevenson, President, in the chair.—The President delivered an address, in which he discussed the erection of training-walls at the mouth of the Mersey. He would strongly condemn such a procedure, asserting that the inevitable result would be the silting up of the approaches to Liverpool.—Prof. Tait submitted a paper on condensation and evaporation. He pointed out that the present mode of treating the conditions of a liquid in presence of its vapour were not rigorous, inasmuch as the pressure is undoubtedly different in the two parts, while in the surface-layer between them there is a complex form of stress. If attention be confined to the isothermals of the interior parts of a liquid, or of its vapour, the present method will apply rigorously. With this proviso the isothermals under the critical point consist of two parts separated by an asymptote—one belonging to the liquid, the other to the vapour. This accords with the fact that liquids can be subjected to hydrostatic tension, and that Aitken has shown that true vapour cannot be condensed without a nucleus.—Mr. John Rattray, of the Granton Marine Station, communicated a note on Ectocarpus.—The Rev. J. M. Macdonald exhibited some specimens from Philadelphia which had the appearance of large vegetable fossils. Mr. John Murray and Prof. Duns pronounced them to be merely inorganic accretions around reeds.

Mathematical Society, February 13.—Mr. A. J. G. Barclay, President, in the chair.—Prof. Tait communicated a note on a plane strain, which was read by Mr. W. Peddie; Dr. Muir gave an account of a paper by Mr. P. Alexander on Boole's proof of Fourier's double integral theorem, and afterwards enunciated several theorems of his own on the arbelos; Mr. Peddie discussed reflected rainbows; Mr. Allardice gave a note on spherical geometry: and Mr. A. Y. Fraser made some remarks on a problem in plane geometry.

CAMBRIDGE

Philosophical Society, February 2.—Prof. Foster, President, in the chair.—Prof. C. S. Roy, M.A., was elected a Fellow.—The following communications were made:—On the Zeta-function in elliptic functions, by Mr. J. W. L. Glaisher.—On a certain atomic hypothesis, by Prof. K. Pearson. Communicated by Mr. H. T. Stearn.—On a Young's eriometer, by Mr. R. T. Glazebrook.

PARIS

Academy of Sciences, February 16.—M. Bouley, President, in the chair.—On the inaccuracies committed in the employment of the usual formulas in the reduction of the polar stars and in determining the astronomic collimation. The correct terms required to remove these errors. Method of observing the polar stars at any meridian distance, by M. Lœwy.—Description of the nervous system of *Ancylus fluviatilis*, by M. H. de Lacaze-Duthiers.—On the order of appearance of the first vessels in the leaves of the cruciferæ; third part, *Crambe maritima*, *juncea*, and *cordifolia*, by M. A. Trécul.—Experiments on some phenomena of the movement of water in an apparatus employed to raise the liquid by means of a mechanical fall without piston or lifting valve, by M. A. de Caligny.—On the resistance of keels in connection with the velocities of 20 and 21 knots an hour recently obtained without special extra motor power, by M. A. Ledieu.—On the oïdium, *Phoma vitis*, mildew (*Peronospora viticola*), and some other cryptogamic diseases prevalent for some years past in the European vineyards, by M. H. Marès.—On the density and figure of the earth, by Gen. L. F. Menabrea. The author's researches tend to confirm the anticipations of Newton that the mean density of the earth would be found to lie between five and six times that of water.—On the development of the vascular apparatus, and of the reproductive organs

in the comatulæ, by M. Edm. Perrier.—Extraction of the green colouring matter of leaves; definite combinations formed by chlorophyll, by M. Er. Guignet. — On some theorems in algebra, by M. Stieltjes.—On the heating power of coal-gas in various states of dilution, by M. A. Witz. From his experiments the author infers that the complete combustion of gas requires a dilution of over six volumes of air, the effect of the dilution thus being the reverse of what might be supposed *à priori*.—On the laws of solution, by M. H. Le Chatelier. From his researches the author concludes that solubility increases with the temperature for bodies whose solution absorbs heat, decreases for those that liberate heat, and remains unchanged when the heat of solution is null.—On the solution of the carbonate of magnesia by carbonic acid, second note, by M. R. Engel.—On a crystallised hydrate of phosphoric acid, by M. A. Joly.—Note on the cellular structure of cast steel, by MM. Osmond and Werth.—On glycol, its preparation and solidification, by M. G. Bouchardet. A very pure preparation of glycol, obtained by a solution of carbonate of potassa acting on the bromide of ethylene, was found to boil at 198° C., and to solidify at temperatures varying from $-11°\cdot5$ to $-25°$.—Note on monochlorhydric glycol, by M. G. Bouchardat.—Action of the diastase of malt on natural starch, by M. L. Brasse.—On the rotatory power of the solutions of cellulose in Schweizer's liquid, by M. Alb. Levallois.—Observations regarding the organisms to which fermentation is due; claim of priority of discovery in connection with some remarks of M. Pasteur on a recent note of M. Duclaux, by M. A. Béchamp.—Note on the anatomical structure and classification of *Halia priamus* (Risso), by M. J. Poirier.—On the anatomy of the brachiopods of the genus Crania, by M. Joubin.—On the nervous system of a Fissurella (*F. alternata*), by M. L. Boutan.—On the origin of the metalliferous ores existing on the periphery of the central plateau of France, and especially in the Cevenne highlands, by M. Dieulafait.—On the results of M. Sokoloff's studies on the formation of sandy dunes in Central Asia, by M. Venukoff.

BERLIN

Physiological Society, January 21.—Dr. von Monakow, referring to his anatomical investigations of the brain, communicated an account of those relating to the central origin of the optic nerve. He had enucleated on one or both sides the bulbus in young rabbits and cats, and, after an interval of some months, examined the changes which had set in as a result of that violence done to the brain. In each case he found regular ascending atrophy capable of being traced up to the origin of the nerves. By this means he had been able to recognise as central original spots of the nervi optici the corpus geniculatum externum, the pulvinar and the anterior corpora quadrigemina. The corpus geniculatum and the pulvinar consisted of large multipolar cells, between which lay a gray medullary substance, which, on being coloured with carmine, showed a particularly strong tinge. After the enucleation, atrophy of the gray medullary substance was observed in both, while the cells remained altogether intact. On colouring with carmine, the somewhat shrunken organs appeared much paler than in the normal state. In the corpora quadrigemina five different layers of small and large cells and fibrous bands were distinguished. Of these the three innermost layers lying towards the ventricle remained intact, while the two exterior cellular layers were atrophied or were altogether wanting. The degeneration and disturbance of growth after the enucleation of the bulbus had not, however, extended beyond these primary centres of the optic nerve. Dr. von Monakow had, furthermore, removed particular parts of the cerebral cortex lying within Munk's sphere of vision, and the degeneration and atrophy which succeeded this injury, and, extended peripherically, could be followed through Gratiolet's fibres on to the three centres of optic nerves above mentioned, the corpus geniculatum externum, the pulvinar and the anterior corpora quadrigemina (*Vierhügeln*), and beyond these centres as far as the tractus opticus and the optic nerves. It was an interesting fact that after the injury of the cerebral cortex the degeneration of the three centres of optic nerves was of a different character from that which set in after the peripherical enucleation. The corpus geniculatum and the pulvinar were now altered in such a manner that it was mainly the cells which either showed degeneration or were entirely wanting. In the anterior corpora quadrigemina, likewise, it was other layers—namely, the third medullary layer and the larger cells—which were overtaken by degeneration. The speaker had had the opportunity, in making a dissection, of substantiating on a man who had long been suffering from diseased retina, that the degeneration in the case of man propagated itself centrally—towards the three centres before-mentioned—just as much as in the case of the rabbits operated on.—Dr. Weyl spoke on casein, which took quite an exceptional place among albuminous bodies. According to the most recent researches albuminous bodies contained only O, H, N, C, and S, but no phosphorus, and might be divided into (1) albumins or albuminous bodies soluble in water; (2) globulins, insoluble in water, but soluble in solution of common salt; (3) proteins, soluble neither in water nor solution of common salt, but in diluted alkalis. Finally, a fourth group of albuminous bodies was formed by such as were soluble in none of those reagents, but, except in this one characteristic, had no affinity to each other, such as fibrin, amyloid, casein, &c. Casein had hitherto been identified only in milk. It was an albuminous body, because under the agency of diluted muriatic acid and pepsin it yielded a pepton, and, besides, precipitated an insoluble substance, which must be classed among the nucleins. Casein contained phosphorus, and so was distinguished from all other albuminous bodies. In order to the demonstration of casein and its quantitative determination in milk, Dr. Weyl had, in conjunction with Dr. Frentzel, adopted a new and less detailed process than that of Prof. Hoppe-Seyler so universally introduced into practice. This new process consisted in diluting the milk threefold and reducing it with highly diluted sulphuric acid (1 : 1000). Thereupon a flaky precipitate at once segregated itself, which could be filtered off and weighed. The precision of this method was equal to that of Hoppe-Seyler's, and by means of it Dr. Weyl and Dr. Frentzel had begun to study quantitatively the transformation of casein into pepton and nuclein. The speaker hoped to be able soon to make communications regarding the result of this investigation.—Dr. Rossel had examined the nuclein of the yolk, in order to test the assertion of Mr. Michat that it resembled the nuclein of cell-nuclei, an assertion which lent a chemical support to the view of Prof. His that the granules of the yolk entered as organic elements towards the upbuilding of the embryo, and formed the cell-nuclei. Dr. Rossel had isolated the nuclein of the yolk of hen-eggs, and, on examining it, had found it essentially different from the nuclein of cell-nuclei. While this latter contained the highly nitrogenous organic bases guanin and hypoxanthin, none of these bases were found in the nuclein of the yolk. The nuclein of the yolk was, therefore, essentially different from that of the cell-nuclei, and under the demonstration of this difference the support which, from the chemical side, had been afforded to the view of the transference of granular formations of the yolk into cell-nuclei, fell away.

CONTENTS

THURSDAY, MARCH 5, 1885

ORE DEPOSITS

A Treatise on Ore Deposits. By J. Arthur Phillips, F.R.S., &c. Demy 8vo, pp. 624 and Index; 95 Woodcuts and 1 Plate. (London: Macmillan and Co., 1884.)

A WORK in the English language upon ore deposits has long been wanted, and geologists and mining engineers may be congratulated that one so well qualified to do justice to the subject as Mr. Phillips, undertook the laborious task of writing a general treatise.

Mr. Phillips divides his book into two parts; Part I., occupying one-sixth of the volume, treats of ore deposits in general, and Part II. is devoted to a description of the principal metal-mining regions of the world.

We are glad to see that he admits a wide definition of the term "ore:" "Although perhaps not strictly correct, any material obtained by mining that contains a workable proportion of a metal is often called an ore, even if the whole of the metal be present in the native state." This is a common-sense and practical way of dealing with the question.

The classification of ore deposits is in the main the same as that adopted by Whitney, in his "Metallic Wealth of the United States," thirty years ago. Mr. Phillips divides metalliferous deposits into the following groups:—

I. SUPERFICIAL

a. Deposits formed by the mechanical action of water.
b. Deposits resulting from chemical action.

II. STRATIFIED

a. Deposits constituting the bulk of metalliferous beds formed by precipitation from aqueous solutions.
b. Beds originally deposited from solution, but subsequently altered by metamorphism.
c. Ores disseminated through sedimentary beds, in which they have been chemically deposited.

III. UNSTRATIFIED

a. True veins.
b. Segregated veins.
c. Gash veins.
d. Impregnations.
e. Stockworks.
f. Fahlbands.
g. Contact deposits.
h. Chambers or pockets.

This classification is the only blemish of any importance in the volume, and we greatly regret that the author did not cast off the trammels of tradition and strike out a new line for himself.

In the first place, we are disposed to quarrel with the separation of superficial deposits, as described by Mr. Phillips, from stratified deposits; we do not see how they can be logically separated. Speaking of the old auriferous gravels of the Sierra Nevada of California, the author's words are:—"These, which are sometimes known as *blue gravels*, were formerly believed to be of marine origin, but are now recognised as materials brought down by the agency of currents of fresh water from the mountains high above them and deposited, either in the beds of ancient rivers, or in lake-like expansions of such streams." Surely, therefore, they are stratified. Furthermore, the term "superficial" should have been avoided as misleading, because the student will naturally infer that the chief characteristic of such deposits is that they occur at the surface; but when we find gold- and tin-bearing gravels buried at a depth of more than 100 feet under other strata and lava-flows of Pliocene or Miocene age, and worked as true mines, the word "superficial" seems singularly inappropriate. The author admits that the term "might at first sight appear a misnomer," but defends it on the ground that "a volcanic capping is by no means universal, and the uncovered beds of this age are of the greatest importance to the miner." When Whitney's book was written the name was more in harmony with the facts, as the deep leads had not been discovered: but even then there was nothing to justify the separation of the old alluvia from the class of stratified deposits.

The three subdivisions of the stratified deposits are useful for impressing upon the mind the most important varieties of this class; on the other hand, when we come to the unstratified deposits we consider that the author has been unwisely conservative.

Why should the geologist step in and call certain mineral veins "true," and thereby cast a sort of stigma upon others which do not fit in with his preconceived theories? Mr. Phillips, like most authors, uses the word "true vein" as synonymous with "fissure vein"; but as it appears that many of the sheet-like mineral masses called "lodes" or "reefs" by miners are not filled up cracks, it seems a pity that the worship of the "fissure vein" should be continued.

A useful summary is given of the various hypotheses which have been propounded concerning the genesis of mineral veins, and due attention is paid to the discoveries of Prof. Sandberger, which have an important bearing upon the theory of lateral secretion. The author ultimately concludes that both lateral secretion and the ascension of mineral-bearing waters have contributed to the filling up of fissures with the various minerals now constituting the veins.

Though he keeps up the old subdivision of "segregated veins" as distinct from true veins, Mr. Phillips is justly doubtful whether such a distinction can always be logically maintained.

With reference to the "impregnations," it is probable that some of the most important Cornish tin lodes in granite may be classed under this head, and therefore this subdivision might be made to include a good deal more than the *carbonas.*

The word "Stockwork" is unfortunately consecrated by long usage, and it will not be easy to evict it from mining literature; but it is a pity that no English term has been coined to denote this mode of occurrence. Speaking of Polberrow mine, Mr. Phillips says it "appears to be the only stockwork ever extensively worked in clay slate." This is not the case. The three openworks in Cornwall known as Minear Downs, Mulberry and Wheal Prosper are other instances of stockworks in clay slate. They produced 203 tons of dressed tin ore in 1883, and the excavations are certainly sufficiently large to say that the deposits have been "extensively worked." Henwood's account of Wheal Music (*Trans. Roy. Geol. Soc. Cornwall*, vol. v. p. 98) shows that it was a stockwork in clay slate, worked for copper ore.

It seems a mistake to retain the "fahlbands" among the unstratified deposits. They are pyritiferous beds among metamorphic rocks. At Kongsberg they consti-

tute the *congenial country* and not the deposit worked; whilst the Skutterud fahlbands, which are simply cobaltiferous quartzite and mica schist, deserve a place among the stratified deposits quite as much as the magnetite of Arendal or Philipstad.

In Part II. we consider that Mr. Phillips does good service by giving statistics of the production of ores, in addition to the descriptions of their modes of occurrence. As stated by him in the preface, "This appears to be the only way of accurately expressing the relative importance of different metalliferous regions." This feature of Mr. Phillips's book, apart from anything else, at once renders it more valuable than the works of von Cotta, Grimm, and von Groddeck.

The United Kingdom is so rich in minerals that a large amount of space is very fairly allotted to it, and, though Cornwall receives the lion's share of attention, it must be recollected that it is the birthplace of British mining and the school from which a set of hardy and intelligent miners have been dispersed among all parts of the globe.

Speaking of an issue of carbonic acid gas from the lode at Foxdale Mine in the Isle of Man, the author says (p. 212): "At the present time (1883) in the eastern end of the 185-fathom level, the amount of gas is so large that, although volumes of compressed air are continually being poured in from two air-pipes, the men experience the greatest difficulty in working; and, as candles will not burn, the value of the end can only be determined by the ore brought out." This account is somewhat overdrawn. The gas has been troublesome at times, but not to the extent stated, for we are led to infer that the men worked in the dark. Even a Manxman is scarcely capable of driving levels without a light.

The small value of the metalliferous ores raised in France is remarkable, and the prosperity of the Belgian metal mines appears to be on the wane, as the value of the metalliferous minerals decreased from 563,080*l.* in 1872 to 148,720*l.* in 1881.

The famous mines of the German Empire at Commern, in the Upper and Lower Harz, the Mansfeld district and the Erzgebirge are described at as great a length as the space available in a general treatise will admit, and many interesting and important details are given concerning the mines of Austria, Hungary, Italy, Greece, Scandinavia, Spain, and Russia. The statement, "Spain takes the lead of all other countries in the amounts of lead and quicksilver which it produces," is scarcely accurate, unless Mr. Phillips is referring solely to Europe. The United States are now the greatest producers of lead, and the Californian quicksilver mines have for several years surpassed those of Almaden in productiveness. However, as far as the output of quicksilver last year is concerned, Mr. Phillips is doubtless correct, for statistics published within the last few weeks show that the yield of California in 1884 was only 1089 statute tons, which is less than the average amount produced by Spain.

The account of the metalliferous minerals of the Australasian colonies will be read with interest. Though the output of gold is on the whole decreasing, tin ore has within the last ten years become a great source of wealth. An important discovery is that there are *deep leads*, *i.e.* old tin-bearing alluvia, of Miocene age, and the figure representing the deposit worked by Wesley Brothers at Vegetable Creek, New South Wales, gives a good idea of this mode of occurrence. It is startling to learn that Queensland produced 106,488 tons of tin ore, worth 2,168,790*l.* in 1881; unfortunately for the colony, but luckily for Cornwall, the output of the following year was only 27,312 tons.

It was certainly no easy task for Mr. Phillips to compress into 65 pages an account of the principal metalliferous regions of the United States: but he has succeeded in furnishing a very useful *résumé*, the only fault of which is the meagreness with which it has been illustrated. The metal mines of the United States deserve more than seven woodcuts, and we should like to have seen figures to explain the wonderful deposits at Leadville and on the shores of Lake Superior.

It is to be regretted that apparently there is so little available information concerning the mines of Mexico, a country so highly favoured as far as mineral wealth is concerned. South America, too, has to be treated very summarily.

Excepting for having followed a beaten track in his classification, the author deserves much praise for his work. The descriptions of the metal-mining districts are very good, being based upon personal knowledge and the latest published accounts; both Mr. Phillips and his assistant, Mr. Brough, must be commended for the care with which they have ransacked all sorts of British and foreign publications relating to mining. The references are very full and complete, and much vigilance has been exercised in correcting for the press. Finally, we must congratulate the author upon his excellent index, occupying no less than twenty-five closely-printed pages. This adds greatly to the utility of the book, which will doubtless become the standard work upon ore deposits.

OUR BOOK SHELF

Madagascar and France: with some Account of the Island, its People, its Resources, and Development. By George A. Shaw, F.Z.S. (London: Religious Tract Society, 1885.)

THE incident connected with Mr. Shaw's imprisonment on board a French war-ship at Tamatave will be remembered—an incident for which the French Government had to make substantial amends. Mr. Shaw has been a missionary in Madagascar for many years, and has thus had ample opportunity of gaining a knowledge of the interesting island. To those familiar with the literature of Madagascar the volume will not present much of novelty; it is, however, interesting reading, and contains some of the results of Mr. Shaw's own observations. On the physical geography and ethnology of this country there is nothing new, but Mr. Shaw presents the results of previous investigations clearly and briefly. He in the main adopts the generally-accepted conclusions as to the Malay origin of the bulk of the Malagasy people, though we suspect that the aboriginal Vazimba are greater, and the intercourse between the mainland and the island of much older date than he is prepared to admit. He gives many interesting details as to the industries of the people, their social habits, the progress of Christianity and education, the past history of the island, and other points. A large portion of the volume is occupied with the history of the relations between France and Madagascar, in which he tells the story of his own imprisonment. To the scientific reader the concluding chapters on the fauna, flora, and meteorology of the island will prove useful; they summarise what is

already known, with some additional facts obtained by the observation of himself and his brother missionaries. There is a map and a few good illustrations.

Three Months in the Soudan. By Ernestine Sartorius. (London: Kegan Paul and Co., 1885.)

MRS. SARTORIUS spent most of her three months in 1883-84 at Suakim, of which her husband, Gen. Sartorius, was Commandant. Her book deals chiefly with the events which culminated in the disaster of El-Teb. It is mostly a pleasant, gossipy record of the daily life of the town, and of the alarms created by the attempted raids of the rebellious natives in the district around. It affords a good idea of the character of the town and its immediate surroundings.

Lectures on Agricultural Science and other Proceedings of the Institute of Agriculture, South Kensington, London, 1883-84. (London: Chapman and Hall.)

THIS volume contains abstracts of lectures delivered by a considerable number of well-known authorities upon agricultural matters. Mr. Carruthers and the late Prof. Buckman give their experiences upon grasses and farm seeds; Prof. Wrightson has a paper upon land drainings; dairy management and farm crops are treated of by Professors Huldon and Fream and Mr. Bernard Dyer; Mr. Henry Woods contributes lectures upon Southdown sheep and ensilage; while Mr. Warrington has a contribution upon the nitrogenous matter in soils; and Mr. Worthington Smith gives some good observations upon corn mildews. The names of the authors of the various lectures are a sufficient guarantee of their soundness and worth.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Sir William Thomson's Baltimore Lectures

As it is possible that some of your readers may have obtained copies of the Papyrograph Report of my Lectures on "Molecular Dynamics," delivered at Baltimore during October 1884, I should be obliged by your giving publicity to the following corrections:—

Page 34, lines 18 and 19.—Delete "we may call it a dynamox but not a paradox." I have no recollection nor can I imagine what the word was that I suggested as more logical than "paradox"!

Page 59, line 14.—For "Distortional" substitute "Condensational."

Page 296.—In the two expressions for ψ, given in equation (17), insert "tan i" before "$\frac{(\mu^2-1)^2}{\mu^2+1}$"; also, in the expressions for "tan e" and "tan e_1" of equation (20) insert "tan i" before "$\frac{(\mu^2-1)^2}{\mu^2+1}$".

The formula from which these expressions are deduced is correctly given at the foot of page 295.

Page 296.—In line 13 from the top of the page, and in the left hand members of equations (19) and (21), for "ω" and "ω_1" read "ϖ" and "ϖ_1" respectively.

WILLIAM THOMSON

The University, Glasgow, February 27

Civilisation and Eyesight

IT would take too much of your space to discuss at length the theoretical limit of resolving-power as depending upon aperture. The reader may be referred to some papers in the *Philosophical Magazine* for 1879 and 1880, where he will also find references to the work of other investigators. I will only say that (as indicated by the word *fairly* in my statement) resolution admits of various degrees. Doubtless a practised observer would judge a star to be double whose components subtend a decidedly smaller angle than two minutes, but he would not see them separated. I purposely rather understated the case. The higher the visual power of civilised men, the less room is there for savages with eyes of equal aperture to surpass them.

With respect to my short-sightedness in a bad light, I shall be glad if you will publish the accompanying two short papers from the *Cambridge Philosophical Proceedings*. They will show how I was led to make the discovery. RAYLEIGH

"The Use of Telescopes on Dark Nights." By Lord Rayleigh. (From the *Camb. Phil. Proc.*, March, 1882.)

In *Silliman's Journal* for 1881 Mr. E. S. Holden, after quoting observations to a like effect by Sir W. Herschel, gives details of some observations recently made with a large telescope at the Washburn Observatory, from which it appears that distant objects on a dark but clear night can be seen with the telescope long after they have ceased to be visible with the naked eye. He concludes, "it appears to me that this confirmation of Herschel's experiments is important, and worth the attention of physicists. So far as I know there is no satisfactory explanation of the action of the ordinary night-glass, nor of the similar effect when large apertures are used."

It is a well-known principle that no optical combination can increase what is called the "apparent brightness" of a distant object, and indeed that in consequence of the inevitable loss of light by absorption and reflection the "apparent brightness" is necessarily *diminished* by every form of telescope. Having full confidence in this principle, I was precluded from seeking the explanation of the advantage in any peculiar action of the telescope, but was driven to the conclusion that the question was one of apparent magnitude only,—that a large area of given small "apparent brightness" must be visible against a dark ground when a small area would not be visible. The experiment was tried in the simplest possible manner by cutting crosses of various sizes out of a piece of white paper and arranging them in a dark room against a black background. A feeble light proceeded from a nearly turned-out gas-flame. The result proved that the visibility was a question of apparent magnitude to a greater extent than I had believed possible. A distance was readily found at which the larger crosses were plainly visible, while the smaller were quite indistinguishable. To bring the latter into view it was necessary either to increase the light considerably, to approach nearer, or lastly to use a telescope. With sufficient illumination the smallest crosses used were seen perfectly defined at the full distance.

There seems to be no doubt that the explanation is to be sought within the domain of physiological optics. It has occurred to me as possible that with the large aperture of the pupil called into play in a dark place, the focussing may be very defective on account of aberration. The illumination on the retina might then be really less in the image of a small than in the image of a large object of equal "apparent brightness."

"On the Invisibility of Small Objects in a Bad Light." By Lord Rayleigh. (From the *Cambridge Phil. Proc.*, Feb., 1883.)

In a former communication to the Society (March 6, 1882) I made some remarks upon the extraordinary influence of apparent magnitude upon the visibility of objects whose "apparent brightness" was given, and I hazarded the suggestion that in consequence of aberration (attending the large aperture of the pupil called into operation in a bad light) the focussing might be defective. Further experiment has proved that in my own case at any rate much of the effect is attributable to an even simpler cause. I have found that in a nearly dark room I am distinctly short-sighted. With concave spectacles of 36″ negative focus my vision is rendered much sharper, and is attended with increased binocular effect. On a dark night small stars are much more evident with the aid of the spectacles than without them.

In a moderately good light I can detect no signs of short-sightedness. In trying to read large print at a distance I succeeded rather better without the glasses than with them. It seems therefore that the effect is not to be regarded as merely an aggravation of permanent short-sightedness by increase of aperture.

The use of spectacles does not however put the small and the large objects on a level of brightness when seen in a bad light, and the outstanding difference may still be plausibly attributed to aberration.

MR. CARTER's recent paper on "Civilisation and Eyesight" has called up interesting remarks from Lord Rayleigh and Mr

J. R. Capron, but there seems to be a factor yet unconsidered connected with sharpness of eyesight which is not dependent on the varying aperture of the pupil of the eye. The same amount of light exerts different degrees of stimulus on different individuals, and even in the same person the optic nerves are differently affected, according to his health or age. The pathologist is familiar with the exalted irritability induced by inflammation.

The observer of close double stars becomes in time painfully aware that through age his power of appreciating minute points of light is blunted, although his eye may be in a healthy condition, and quite equal to microscopic work under suitable illumination.

The flattening of the cornea, together with the slow reduction of the curves of the crystalline lens, is a common occurrence, and this change is said to commence at the age of forty-five.

Modification of form and the inability to vary the distance between the lens and the retina, due to defective power in the muscles of the iris, are the chief causes of short sight. On the other hand, the eye appears to have great capabilities of modifying itself to circumstances. It may degenerate by disuse, and even become obliterated, as may be seen in the blind aquatic beetles of dark caverns, the flea of the bat, and in many species of underground Aphides. Similarly it would seem that the eyes of the student who habitually pores over half-legible German or other type, or the eyes of the watchmaker or the engraver, who use lenses, will permanently accommodate themselves to the short foci required to view objects at short distances, and such modifications may be conceived to become hereditary.

The pupil of the eye perhaps has an aperture wide enough to admit the pencil of light from any telescope; yet it may be worth some consideration whether the sensitiveness of the eye may not for certain purposes be increased, under due precautions, by the use of some such drug as atropa belladonna. The iris thus might be made less contractile under the overpowering light of a planet, and perhaps allow a better observation of a minute satellite revolving close to its primary. It is a well-recognised fact that a faint star once seen may often afterwards be detected with comparative ease by other persons, if its position be truly shown.

Venus may be often seen in broad daylight, if the planet be pointed to by suitable marks.

Care of course would be taken that the use of belladonna shall not cause the observer to see too much. G. B. BUCKTON

THE controversy in NATURE on this subject has brought back to my thoughts a singular illustration of the power of trained eyesight which seems worth noting, though it does not touch the exact comparison between savage and civilised eyes which is the immediate subject of the letters which have appeared in your columns. I refer to the vastly greater capacity for determining visual direction supplied by the sense of symmetry than by actual discrimination between two slightly distant visible points. If you look at a circle, you can aim at its centre with far greater exactitude than you could aim at a point in the true centre of the figure. Every rifleman and every billiard-player exemplifies this. Suppose a billiard-ball placed a little less than five feet from a pocket, and played at as a half-ball stroke from an equal distance for a winning hazard. This is something like what has to be done from baulk in making a pair-of-breeches stroke into the corner pocket. A fair amateur will pot his ball pretty often; a first-rate professional will do it very often. No one, perhaps, can make it a really safe stroke. But observe the accuracy required. The margin of error allowed on each side of the perfect stroke is, on a severe table, not more than an inch at the pocket. This allows an error on each side of about one degree in the point of impact with a radius of one inch (the ball being two inches in diameter). This one inch subtends at the distance from which the stroke is played (nearly 5 feet), an angle of $1^\circ \times \sin 60^\circ, \frac{1}{60}$ = about ·8′. To make the stroke you must first, by eye, place your striking-ball right, then you must, by eye, aim the stroke right, and finally you must make the muscles follow the eye rightly. These three elements of error combined must leave a resultant error of not more than four-fifths of a minute; that is to say, a successful stroke must have a total angular error very considerably less than the smallest angular distance which the eye can appreciate between two visible points. This, of course, explains also the superiority of a rifle foresight, which surrounds the object by a symmetrical figure over one which depends on making one point visibly cover another. G. W. H.

Human Hibernation

As it is obvious that Mr. A. H. Hulk is unacquainted with the facts of what he designates a "well-known Indian trick," and as the matter is one of considerable physiological interest, I think it well to place before your readers the nature of the evidence which satisfied me of the genuineness of this condition, when I referred to it in the fourth edition of my "Human Physiology," published thirty-two years ago—a reference retained by the present editor of that treatise. This evidence had been obtained by Mr. Braid from Indian sources, and published by him in a collected form in 1850, the greater part of it having previously appeared in the pages of the *Lancet*. The most important feature of it was the testimony of British medical officers who witnessed the exhumation—most explicitly given in at least three distinct cases—*to the corpse-like condition of the buried man*, a condition which could not be simulated.

I have since learned from a variety of trustworthy sources, that similar testimony has been over and over again given in India by competent witnesses. Moreover, in one of the cases adduced by Mr. Braid, on information supplied to him direct by the British resident in the summer-house of whose garden the man was buried, the circumstances of the inhumation and of the exhumation were such as absolutely to exclude the "tunnel" hypothesis; while in the case narrated by Lieut. A. Boileau in his "Narrative of a Journey in Rajwarra," 1835, the man was buried in a grave lined with masonry and covered with large slabs of stone.

It is further worthy of mention that this performance is not carried on for the sake of gain, but as a religious observance. Many years ago Prof. Max Müller, finding that I was interested in the matter, kindly placed in my hands a pamphlet printed in India, containing a summary of what is termed the Yoga or Yogi philosophy. The devotees of this system have from time immemorial been in the habit of artificially inducing states of more or less complete abstraction, corresponding closely with those of Braidism; and the condition of apparent death, in which the soul is supposed to leave the body for a time, for communion with the higher world, is the culmination of these conditions, only to be reached by the few; to whom, in consequence, a character for the highest sanctity attaches itself.

With the well-authenticated fact of Col. Townsend's self-induction of a state of apparent death, and of his spontaneous recovery from it, as a "leading case," I cannot regard it as incredible that such a condition of "dormant vitality" might be prolonged for days, weeks, or even months, *in a warm atmosphere*. The suspension of the heat-producing power would of course leave the body susceptible of a fatal reduction of temperature, if its warmth were abstracted by a surrounding medium much cooler than itself WILLIAM B. CARPENTER

Athenæum Club, February 20

Methods of Determining the Density of the Earth

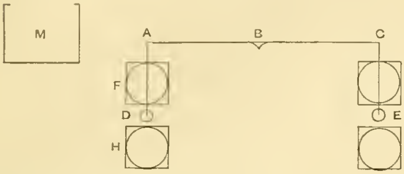
I HAVE just seen in the report of the proceedings of the Physical Society (NATURE, January 15, p. 260) the account of the ingenious and very important experiments proposed by Drs. König and Richarz to determine the density of the earth. I would suggest that mercury be substituted for lead as the attracting masses. The homogeneity of density, the precision with which its density and temperature can be determined, and the ease with which transport from one side of the balance to the other can be effected will commend the use of mercury. The mode of experimenting suggested is the plan of Cornu—used in his determination of the density of the earth by the (Cavendish) Michell experiment—adapted to the same determination by means of the balance.

Let A, B, C be the balance, D E the attracted balls, and F G, H I, the attracting masses of mercury contained in iron spheres of the same capacity, size, and weight. A large mass of mercury is contained in the vessel M, so placed that it has no effect on the balance or on D or E. The balance being in equilibrium with the mass D and E, mercury is allowed to fill F and I, and the effect noted in oscillations after F and I are filled. Then the mercury is drawn from F into H, and G is filled from the reservoir M, and I is emptied, and the second observation obtained. Then D and E are interchanged, and a third observation obtained. Then the mercury in G is run into I, F is filled, and H emptied, and the third observation made, the combination of these four observations making one determination. Electrical effects of

the friction of the mercury are avoided by connecting the vessels by wires with the earth.

If H and I form a mass of lead, I infer that three interchanges of D and E will be required, so that each weight shall be brought opposite the top and bottom of each mass to eliminate want of homogeneity in the lead. In the plan I propose only one interchange will be needed.

The effect, if any, of the vessels full of mercury being at



unequal distances from the arms of the balance can be readily determined and allowed for.

The plan I suggest may have already presented itself to the eminent scientists who have originated their notable improvement on Von Jolly's plan. The pleasure I had in reading the account of their proposed research has prompted me to make these suggestions. ALFRED M. MAYER

Stevens Institute of Technology, Hoboken, New Jersey, February 7

Bees and Flowers

As there is a prevailing idea that bees prefer red and blue to other colours, the following observations on their habits may be of interest:—The common hive bees were very busy among the flowers in the garden this morning. Those most frequented were yellow crocus, snowdrop, and Christmas rose. Next in order, winter aconite, yellow jessamine, and blue scilla. On sweet blue violets and on a dwarf erica, which is now flowering, I could see none. Hitherto my observations led me to suppose they never visited the blue scilla for honey, as I had never seen them settle down to it in a business-like manner, but simply flit over it and go to something else. G. W. BULMAN

Corbridge-on-Lyne

Free Lectures

I OBSERVED in NATURE for February 19 (p. 367) a reference to the free lectures at Liverpool, and the inquiry, Why cannot the same thing be done in other large towns? It may interest your readers to learn that a series of free lectures has been given during the past two winters by the professors of this College. Tickets for these lectures are distributed through the agency of a committee composed partly of employers, and the attendance at each lecture numbers between 600 and 700. The audience consists wholly of persons in receipt of weekly wages, the services of the lecturers are given gratuitously, and no charge whatever is made for admission. The small expenses of printing and issuing programmes and tickets are defrayed by the Committee. I inclose the syllabus of this, the second year's course, now drawing to a conclusion.

In addition to these lectures we have from time to time free lectures by gentlemen possessing special knowledge of the contents of the Free Libraries. These, too, are attended by a large number, chiefly of working people, and when the art galleries are completed next year arrangements of a similar kind will doubtless be made in connection with them. WILLIAM A. TILDEN

The Mason Science College, Birmingham, February 24

A Tracing Paper Screen

I CAN add to the testimony of Mr. Charles Taylor about the efficiency of a screen of tracing paper. I have used for several years a small screen of tracing cloth mounted on rollers like a map. It is very portable and soon fixed. With a sciopticon lantern (oil lamp) I have shown transparencies in the winter months to an audience of seven hundred men in a Midland Railway mess-room during the breakfast hour—8.15 to 8.50 a.m.—though the windows are by no means in the best position, and the room is lighted by skylights as well as by side windows. It is a pity this screen is not better known and more extensively used for scientific lectures. H. ARNOLD BEMROSE

Irongate, Derby, February 28

An Author's Gratitude

I WISH to express my gratitude to NATURE and to the reviewer in NATURE of my little pamphlet on Electrical Units for exposing a compound error by which the farad came to be described as a fraction of the electrostatic C.G.S. unit of capacity instead of the electro-magnetic unit. Was there ever a greater blunder? It was as if I had said the value of the tenth part of a farthing is sufficient to pay off a million times the National Debt of Great Britain. On recovering from the shock occasioned by the revelation, I hastened to the printer, and got him to correct the error "ere the sun went down," and now I overflow with gratitude to your reviewer, who has relieved me of the awful incubus of an error of the 10^{20} magnitude. RICHARD WORMELL

SCIENTIFIC LABORATORIES[1]

I FEEL that the present occasion, upon which you have done me the honour to ask me to preside, is one of very great importance indeed, and I wish some person more competent to preside on such an occasion and give a suitable inaugural address were in my place. I am afraid I must confine myself to something not at all worthy of the greatness of an occasion which is almost the opening of a new university. Not quite so, because the real opening of this college took place several months ago; but still it is an occasion which I feel to be much more than merely the opening of a department—a working department—in the college; an occasion of so great moment that I regret that I shall not be able to give anything that could be properly considered a worthy inaugural address. I shall be obliged to ask your indulgence if I confine myself specially to departments with which I am personally familiar—scientific laboratories. The laboratory of a scientific man is his place of work. The laboratory of the geologist and of the naturalist is the face of this beautiful world. The geologist's laboratory is the mountain, the ravine, and the seashore. The naturalist and the botanist go to foreign lands, to study the wonders of nature, and describe and classify the results of their observations. But they must do more than merely describe, represent, and depict what they have seen. They must bring home the products of their expeditions to their studies, and have recourse to the appliances of the laboratory properly so-called for their thorough and detailed examination. The naturalist in his laboratory with his microscope and appliances for the keenest examination, learns to know more than can be learned by merely looking at external beauties. The geologist brings his specimens to the chemist—is himself a chemist perhaps—brings his crystals to the physical laboratory to be examined as to their physical properties, their hardness, the angles between their faces, their optical qualities. Some people might think this an ignoble way to deal with crystals. But it is not so to the trained eye and deeper thought of the scientific man. The scientific man sees and feels beauty as much as any mere observer—as much as any artist or painter. But he also sees something underlying that beauty; he wishes to learn something of the actions and forces producing those beautiful results. The necessity for study below the surface seems to have been earliest recognised in anatomy, and earliest carried out in human anatomy. I am not going to speak of the work of scientific research generally, but with reference to the special occasion which brings us here this day—the opening of the chemical and physical laboratories of the University College of North Wales. I am going to speak

[1] Address by Prof. Sir William Thomson, F.R.S., on the occasion of the opening of the Laboratories of University College, Bangor.

of laboratories for students, laboratories in which the students work with their own hands. There have been laboratories of investigation from the earliest times. No doubt Aristotle had his; and Archimedes had a laboratory wherever he went—in his bath, even, he observed, and studied, and thought out the laws of hydrostatics. But those were not students' laboratories, and our special subject to-day is a students' laboratory, where they can meet together for the practical study of the various departments of science, where they will be brought together to use their eyes and hands—their eyes otherwise than in merely reading books and looking at pictures or drawings; their eyes to observe accurately, and their hands to experiment, in order to learn more than can be learned by mere observation. To teach students to so work and so learn is the object of a scientific students' laboratory.

The first scientific laboratory that ever existed was that of Frederick II., King of Sicily, and was established between 1200 and 1250. Acting under the advice of his chief physician, Martianus, he made a law that nobody should practise physic or surgery without having studied anatomy practically. He established a school of practical anatomy, to which students flocked from all parts of Europe for many years. Subsequently there was an anatomical school instituted at Bologna; and in those two schools we hear the first of students working in laboratories. The anatomical students' working-room has for several hundred years been generally recognised as an absolute necessity of medical education. But I believe there was no other branch of physical science where students worked in the laboratory until probably twenty years of the present century had passed away. The University of Glasgow is, I think, justly entitled to take some pride in the great modern expansion and extension of the system of giving students practical work in laboratories, as an addition to the education which previously had been confined almost entirely to book-work, or, at best, to attending lectures illustrated by experiments and diagrams. The first chemical laboratory for students, so far as I know, was that founded by a colleague of my own name, though no relation—Thomas Thomson,[1] the great chemist and mineralogist. Prior to 1831 a students' chemical laboratory, under Thomas Thomson, at Glasgow University, flourished and was attended by a large number of students. These were chiefly medical students, but a considerable number also were students who wished to learn chemistry to practise it in the various chemical manufactories in Glasgow and the North of England, while some went to learn chemistry solely for the sake of science. A chemical laboratory has now become indispensable in all universities. A notable development of chemical laboratories with reference to practical education in chemistry, was made by Liebig not many years after 1831. I fix that date from personal recollection. In 1831 I first came to Glasgow, and I well remember that the building containing the chemical lecture room and laboratory existed then. How long before 1831 it was built I do not at this moment recollect. The world-renowned laboratory of Liebig brought together all the young chemists of the day. If I were to name the great men who studied at Giessen I should have to name almost every one of the great chemists of the present day who were young forty years ago. His laboratory was in full and flourishing activity between 1841 and 1845, and continued so for several years more until he migrated to Munich. It is still, I believe, a prosperous institution, carrying out the aims of its founder with undiminished zeal and energy. One of those chemists now living, who was young forty years ago, told me a few days since that Liebig's laboratory looked like an old stable. I believe the building in which we are now assembled *was* an old stable, but I fail to discover that it looks like an old stable now. If Liebig's laboratory, looking like an old stable, brought out such results to astonish and benefit the world, what must we expect of the beautiful laboratory in which we are now met? What would Liebig not have given for the appliances and advantages afforded by the well-equipped buildings of the North Wales College at Bangor? What would Liebig not have given for the facilities which now exist in these admirably-appointed lecture-rooms in which we are now met, and for the carefully-equipped laboratories and working-rooms, and places for special experimental work covering the area of the old stables and coach-houses of the "Penrhyn Arms Hotel"! If the professors and the students in this College—I think I may already say this thriving College—will be inspired by the zeal of those who have worked before them, a great reward will result even in the first year of the existence of the institution.

With respect to physical laboratories I may be allowed, without being thought egotistical, to say something in which I must speak of my own action. The physical laboratory in the University of Glasgow is, I believe, the first of the physical laboratories of which we have now so many. When I entered upon the professorship of natural philosophy at Glasgow I found apparatus of a very old-fashioned kind. Much of it was more than a hundred years old, little of it less than fifty years old, and most of it was of worm-eaten mahogany. Still with such appliances year after year students of natural philosophy had been brought together and taught. The principles of dynamics and electricity had been well illustrated and well taught: as well taught as lectures and so imperfect apparatus—but apparatus merely of the lecture-illustration kind—could teach. But there was absolutely no provision of any kind for experimental investigation, still less idea, even, for anything like students' practical work. Students' laboratories in physical science were not then thought of. I remember one of the chemists of the Liebig school asking me what was the object of a physical laboratory. I replied that it was to investigate the properties of matter. I could give no better answer now. I may remind you that there is no philosophical division whatever between chemistry and physics. The distinction is that different properties are investigated by different sets of apparatus. The distinction between chemistry and physics must be merely a distinction of detail and of division of labour.

Soon after I entered my present chair in the University of Glasgow in 1845 I had occasion to undertake some investigations of certain electrodynamic qualities of matter, to answer questions which had been suggested by the results of mathematical theory, questions which could only be answered by direct experiment. The labour of observing proved too heavy, much of it could scarcely be carried on without two or more persons working together. I therefore invited students to aid in the work. They willingly accepted the invitation, and lent me most cheerful and able help. Soon after, other students, hearing that some of their class-fellows had got experimental work to do,

[1] [Note added February 12, 1885:—First Professor of Chemistry in Glasgow University; appointed 1818; held the chair till his death, 1852.

The minutes of the Faculty of Glasgow College show that as early as the first month of 1828, Prof Thomas Thomson began applying for more commodious premises in which to carry on his work in the department of chemistry. For two years he kept his wants persistently before the Faculty (of which he, being only a "Regius Professor," was not a member) until January 1830, when his efforts were crowned with success. A plot of ground was then purchased at the corner of College Street and Shuttle Street, outside the College precincts, and operations were at once begun, and pushed on with such vigour that the buildings seem to have been finished towards the end of the same year. The building thus erected contained ample and well-designed accommodation for teaching and experimental work. There was a large class-room and a large and conveniently-arranged public laboratory for students, with private rooms for the professor and for the prosecution of experimental research by the professor and his assistants, or by students and others.

Part of the ground-floor of the premises was let to a tenant (the "Falstaff Tavern" for many years!). To-day I found the building still in existence, and occupied by "George Younger and Co.'s Yarn Stores." Nearly all the rest of the University Buildings within the College precincts have been pulled down within the last twelve years for the "College Railway Station," which now occupies the site of the old Glasgow College and University.—W. T.]

came to me and volunteered to assist in the investigation. I could not give them all work in the particular investigation with which I had commenced—"The electric convection of heat"—for want of means and time and possibilities of arrangement, but I did all in my power to find work for them on allied subjects (Electrodynamic Properties of Metals,[1] Moduluses of Elasticity of Metals, Elastic Fatigue, Atmospheric Electricity, &c.) I then had an ordinary class of a hundred students, of whom some attended lectures in natural philosophy two hours a day, and had nothing more to do from morning till night. Those were the palmy days of natural philosophy in the University of Glasgow—the pre-Commissional days. But the majority of the class really had very hard work, and many of them worked after class-hours for self-support. Some were engaged in teaching, some were city-missionaries, intending to go into the Established Church of Scotland or some other religious denomination of Scotland, or some of the denominations of Wales, for I always had many Welsh students. But about five and twenty of the whole number found time to come to me for experimental work several hours every day. In those days, as now, in the Scottish Universities all intending theological students took the "philosophical curriculum"—*zuerst collegium logicum*—then moral philosophy, and (generally last) natural philosophy. Three-fourths of my volunteer experimentalists used to be students who entered the theological classes immediately after the completion of the philosophical curriculum. I well remember the surprise of a great German Professor when he heard of this rule and usage: "What! do the theologians learn physics?" I said, "Yes, they all do; and many of them have made capital experiments." I believe they do not find that their theology suffers at all from having learned something of mathematics, and dynamics, and experimental physics before they enter upon it. I had then no other premises than the old lecture-room and the adjoining apparatus room. To meet my requirements for my new volunteer laboratory corps, the "Faculty" (the then governing body of the College) allotted to me an old wine-cellar, part of an old professor's house, the rest of which had been converted into lecture-rooms. This, with the bins swept away, and a water-supply and a sink added, served as physical laboratory (a name then unknown) for several years, till the University Commissioners came and abolished a certain old function of Glasgow University, the "Blackstone Examination." The examination room was left unprotected, its talisman, the old "Blackstone Chair," removed. I instantly annexed it (it was very convenient, adjoining the old wine-cellar and below the apparatus room); and, as soon as it could conveniently be done, obtained the sanction of the Faculty for the annexation. The Blackstone room and the old wine-cellar served well for physical laboratory till 1870, when the University was removed from its old site imbedded in the densest part of the city, to the airy hill-top on which it now stands. In the new University buildings ample and commodious provision was made for experimental work.

In that good old time some students used to come to me under the impression that the laboratory would prove an agreeable lounge, where they could meet pleasantly and spend the forenoon talking matters over. They were soon undeceived as to its being a lounge for idly whiling away time. I hope they were not altogether disappointed when they thought it would be agreeable, and I almost hope they found it even more agreeable than they expected. They certainly learned something of patience and perseverance, if not much science, in the six months of the College session. As a matter of general education for those not going to practise medicine, was it of any use entering a chemical or physical laboratory? I found as many as three-quarters of the students were destined for service in the religious denominations in after-life. I have frequently met some of those old students who had entered upon their profession as ministers, and have found that they always recollected with interest their experimental work at the University. They felt that the time they had spent in making definite and accurate measurements had not been time thrown away, because it educated them into accuracy,—it educated them into perseverance if they required such education. Some students even worked so hard in my laboratory that I had to interpose for the sake of their health. There is one thing I feel strongly in respect to investigation in physical or chemical laboratories—it leaves no room for shady, doubtful distinctions between truth, half-truth, whole falsehood. In the laboratory everything tested or tried is found either true or not true. Every result is *true*. Nothing not proved true is a *result*;—there is no such thing as doubtfulness. The search for absolute and unmistakable truth is promoted by laboratory work in a manner beyond all conception. It is a kind of work in which also patience and perseverance are promoted in a most marked degree. No labour must be shrunk from; everything must be carefully done. There is this which is satisfactory about it: that perseverance is sure to be rewarded. There is no failure in physical science. We do not always find the particular thing looked for; we often find that what we looked for does not exist, or that something else exists very different from what we expected to find; but that something is to be found in any investigation entered upon with intelligence and pursued with perseverance, is a certainty; and also that that something is not valueless follows as a matter of course. Every additional knowledge of the properties of matter is of value.

A large part of the work of a physical or chemical laboratory must be measurement. That might seem rather trying work; "harsh and crabbed" shall we say? Who cares to measure the length of a line in land surveying, or of a piece of cord, or of ribbon, or of cloth? These may not be in themselves essentially interesting occupations; but if it becomes necessary to measure something smaller than can be seen with the eye, the measurement itself becomes an object to inspire the worker with the greatest ardour. Dulness does not exist in science. What do you think of a measurement of something you can only gauge by inference from the performance of the apparatus tested in some peculiarly subtle way? The difficulties to be overcome in physical science in mere measurement are teeming with interest. Properties of matter, or forces to be contended with, oblige us to be always digressing. We cannot go on saying—"We will think of nothing but the object before us." Every person who aims at one object of course perseveres until he attains it; but he keeps his mind open until he can return to some other object never thought of at first, but which thrust itself on him as a difficulty occurring in the pursuit of the first object. The very disappointments in attaining objects sought after in the investigations of physical science are the richest sources of ultimate profit, and present satisfaction and pleasure, notwithstanding the difficulties and disappointments contended with. But I am afraid I am taxing your patience too much. I will only just say with reference to physical laboratories that they are now advancing to something of the method and consistent system that Thomas Thomson and Liebig so greatly gave to chemical laboratories. I, myself, have not done so much as I might have done in that way. The physical laboratory at Glasgow has, I believe, been, more than most others, devoted to whatever work occurred in physical investigation, measuring properties of matter, comparing thermometers, electrometers, galvanometers, and doing other practically useful work. We put the junior students at once into investigations, and let

[1] Results up to 1856 published under this title, as Bakerian Lecture for 1856 (*Trans. R. S.*, and republished recently in vol. ii. of "Collected Papers."—W. T.)

them measure and weigh whatever requires measurement and weighing in the course of the investigation. I look with admiration to what has been done by those who have worked up physical laboratories to their present advanced condition. The physical laboratories of King's College and University College, London, under the admirable organisation and work of Professor Adams and Professor Carey Foster; the Cavendish laboratory at Cambridge, originated by Clerk Maxwell, and admirably systematised and perfected by Lord Rayleigh, have rendered splendid services to physical science all over the world. Much has been done even to provide suitable text-books for use in the systematic practical training of students in laboratory work: for example, the "Treatise on Physical Measurement," by Kohlrausch, which has been for several years a most serviceable manual, and the lately published "Practical Physics" of Glazebrook and Shaw. The physical laboratory system has now become quite universal. No university in the world can now live unless it has a well-equipped laboratory. I hope you will all do your best to make the physical and chemical laboratories of this college a great success; that you will follow example in everything exemplary until the Bangor laboratories become a model to be followed in future laboratories in Wales, England, or any other part of the world. I was not quite accurate when I spoke of this new college in this City of Bangor as *the* University College of North Wales. My friend, Mr. Cadwaladr Davies, your secretary, has reminded me that there was a university of North Wales at Bangor-is-y-coed, in Flintshire—not a city, because it did not combine a bishop and a mayor—but a town which had the honour of having been the seat of the first Welsh university known to history. There may have been universities in Wales before the one which flourished 1200 years ago at Bangor-is-y-coed; but their history is lost in the long night of silence, because no sacred bard sung of their existence. The university of Bangor-is-y-coed had its bard, who tells us that the institution had 2100 students. There you have a worthy object of ambition for the city of Bangor! May it soon have a goodly proportion of the 2100. Perhaps not so long a time may elapse before your college and the other colleges in Wales may reach to such a number. Indeed, I do not see anything unreasonable in hoping and expecting that in a dozen years there will be 2100 university-students in Wales. The population of Wales is more than a million and a half, which is, I think, about a fourth of the population of Scotland; and I do not see why Wales should not have university students in proportion to its population as well as Scotland. I believe the brightness and activity of the Welsh intelligence will thoroughly take up the idea of a university, and profit by it to the utmost, and, I believe, the existence of this institution at Bangor will before twenty years have passed away, be looked upon as having been a great benefit to the Principality. What Wales gained by the university at Bangor-is-y-coed can scarcely now be told, but alas, for that university with its 2000 students, it was destroyed in the year 613 by Ethelfred, King of Northumbria, and its destruction was followed by 900 years of dark ages. Thus we see what the world lost by the annihilation of the first university of North Wales. Another bard, Lewis Glencothy, advocated and sang of the possibility of a university in Wales in the time of Henry VII. Richard Baxter, not a Welshman nor a bard but the great English Puritan divine, reported to the then Government under Cromwell in favour of a university for Wales. Cromwell died before action was taken, and nothing was done in the matter for nearly 200 years, when a very active desire sprang up and active co-operation among all parties was entered upon, for having a university established in Wales. We see everything now prospering in that direction. I look forward hopefully to the time when this college of Bangor—if not an independent university of its own—will be a college of the University of Wales. All the colleges of Wales, equipped to do the work of a university, might be united to form a University of Wales. There are very many important advantages in favour of such an arrangement. No doubt it is an object of honourable ambition; but it may be asked if a college does all the work of a university, what does it matter whether it is called a university or not? It is of considerable importance that your college should be either a university itself, or part of a university of which it is an integral college. One of the advantages would be that the teaching of the college would be enabled to take a more practical form than it can possibly take as long as its main purpose is that of preparing students for the degree examinations of London University. The degree system of London University fills a widespread want—a want felt over the whole range of the British empire; a want of marking by the stamp of a university degree, if not by some more suitable title, the possession of knowledge and of a certain amount of training by those who have not had the opportunity of obtaining that knowledge in any thoroughly equipped college or university. That is a splendid reason for the existence of the London University, and it has well fulfilled its reason for existence. But, for all that, it would be greatly better for the students of the University College of North Wales if the teaching were conducted with reference to an examination carried on by their own professors and colleague professors in other properly equipped Welsh colleges. It is the greatest mistake in respect to teaching and examining to think that the examiner is an inspector. An examiner of schools must to some extent take that position. But in university work teaching and examining must go side by side, hand in hand, day by day, week by week together, if the work is to be well done. The object of a university is teaching, not testing. Testing products comes at some times, and for some special purposes, to be a necessity; but in respect to the teaching of a university, the object of examination is to promote the teaching. The examination should be, in the first place, daily. No professor should meet his class without talking to them. He should talk to them and they to him. The French call a lecture a *conférence*, and I admire the idea involved in that name. Every lecture should be a conference of teacher and students. It is the true ideal of a professorial lecture. I have found that many students are afflicted when they come up to college with the disease called "aphasia." They will not answer when questioned, even when the very words of the answer are put in their mouths, or when the answer is simply "yes" or "no." That disease wears off in a few weeks, but the great cure for it is in repeated and careful and very free interchange of question and answer between teacher and student. Professors and students must speak to one another. One of the greatest things is to promote freedom of conversation in such classes, to cultivate in them the power of expressing ideas in words. Then something more definite than *viva voce* examination can come. Written examinations are very important, as training the student to express with clearness and accuracy the knowledge he has gained, and to work out problems, or numerical results, but they should be once a week to be beneficial. If only occurring once in two or three months they will lose their effect in promoting good teaching, and can be scarcely more than a test; if only once a year they are merely inspector's work. The object of the university should be teaching, and examining should only be part of its work, and that only so far as it promotes teaching. The credit of the University should depend on good teaching, and no candidate should be granted a degree who does not show that he has taken advantage of the good teaching. But it is impossible to carry out that programme to best advantage by a college which is not in itself an integral part of a university. Such examinations as those of the London University are necessarily arranged to suit thousands of candidates who have learned in different schools, and

cannot always contain questions that would be most suitable for one particular mode of teaching. The kind of questions set would be of a different nature if the giving of the questions devolved upon those who had in hand the teaching. Those who have the teaching can give an examination vastly more useful and one that would re-act on the teaching in a way that an examination of a multitude of students trained at all kinds of institutions, and many merely by private reading, could not possibly do. Therefore, it seems to be a matter of high importance indeed that there should be a University of Wales; that you should consider it to be a great object to be attained, sooner or later—but the sooner the better—the establishment of the University of Wales, with the University College of North Wales an integral part of it. I have much pleasure in wishing the University College of North Wales every success, and I trust that the laboratories now opened may prove of great value in promoting and aiding the study of science.

POLYNOMIALS IN ZOOLOGY[1]

SINCE the days of Linnæus scientific zoologists have universally adopted the binomial system of nomenclature, which was invented and introduced by that great naturalist. So long as the idea of the fixity of species, as originally created entities, prevailed, there was no excuse for deviating from the Linnean plan. Such an idea as a transitional series between two species, or the division of a species into two or more local forms, was hardly understood by the older authors. But of late years, since the general acceptance of the derivative origin of species, it has become universally acknowledged that sub-species and transitional forms do exist in Nature, and many and various plans have been proposed for indicating them. Trinomials—that is, the usage of three names, of which the last is that of the sub-species—are in great favour with a rising section of American zoologists, and there is much to be said in their defence. But the concession of three terms, it is said, would in some cases not be sufficient. Quadrinomials and Polynomials must necessarily follow, and render nomenclature inconveniently long. Mr. S. Garman, the well-known herpetologist of the Comparative Museum of Zoology at Harvard College, Cambridge, replies, in the pamphlet now before us, to the assertion "that there is no other or better method than "polynomials." Mr. Garman proposes to designate the different forms or sub-species of a species by symbols such as (A), (B), (C), (D). Supposing that the (C) form is found to consist of several sub-varieties he would name them ($C.^{a}$), ($C.^{b}$), ($C.^{c}$). Still further subdivisions might be indicated as forms (C^{a1}), (C^{a2}), (C^{a3}), and ($C^{a1'}$), ($C^{a1''}$), &c. Thus the polynomial "*Amblystoma tigrinum mavortium hallowelli suspectum maculatissimum*" would be reduced to "($C.^{a1'}$) *Amblystoma tigrinum*," the "advantage" of which for general literature is "apparent"! But is not this a case in which it may be said that the proposed remedy is as bad as the disease?

TEMPERED GLASS

WE are very pleased to be able to chronicle an application which Mr. Frederick Siemens has recently made in his regenerative gas radiating furnace, described in the autumn of last year (NATURE, vol. xxxi. p. 7). It consists in the production of glass which appears to be of a very homogeneous character and of considerable strength and hardness, and will doubtless become available for a number of useful purposes. The scientific principle which is applied in the three distinct processes to which we propose to refer shortly, is that of keeping the whole body of the glass at a uniform temperature during the operations of heating and cooling—that is to say, that at each unit of time the whole mass shall be at one temperature. Two methods have hitherto been employed by means of which glass has been rendered more or less independent of variation of temperature. The oldest of these is that carried on in the annealing kiln, in which the manufactured articles of glass are allowed to cool very slowly. The more modern is that of De la Bastie; in this process the finished articles of glass had generally to be annealed in the first instance, then heated to such a temperature as to soften them, when they were immersed in a bath of heated oil maintained at a temperature above 300° C., which was said to make them tough. The objection to annealing is mainly that of cost, but the objection to the De la Bastie process is that it is wrong in principle, as, owing to the manner in which cooling is effected, the glass is in a state of tension throughout, which is brought to evidence by means of the polariscope. The glass produced by the processes to be described are almost free from internal strain, and Mr. Siemens holds that, could the principle he propounds be carried out perfectly in practice, the glass would be free from tension throughout its whole mass. A corollary which may apparently be drawn from this proposition is that every metal not cooled in the way proposed is in strain; but that, owing to the much greater tensile strength of metals, the state of tension does not become evident in the same manner as in glass, which is notably brittle.

Press-hardened Glass.—Only glass of the very best quality is suitable for hardening. It is cut into the proposed shapes and placed in the radiation furnace until soft; it is then removed and placed between cold metal plates, and cooled down in the proportion of its volume or capacity for heat. Glass may be cooled so rapidly by this means that the diamond will not touch it; the process is mostly applied to sheet and plate glass, which may either be plain or decorated, and whose strength is thereby increased eight times. The degree of hardening which may be attained depends on the temperature to which the glass is heated and the rate at which it is cooled. The higher the temperature, and the more quickly the glass is cooled, the harder is the glass. Thus, for very quick cooling copper plates are used in the presses, and the glass is rendered exceedingly hard; when a less degree of hardness is desired, iron plates, or even these covered with asbestos, or clay slabs, may be employed.

Sheet-glass of ordinary thickness is heated in a minute and cooled in half a minute. It is remarkable that this can be effected in so short a space of time without injury to the glass, and is due to the uniformity of the heating and cooling operations. Owing to the high temperature at which this process is carried on, more refractory enamels, such as those used for porcelain, can be applied, and the enamel is thus rendered as indestructible as the glass itself.

Semi-hardening is employed for goods to which presses cannot be easily applied. The glass is heated up to a high temperature, but not to such a degree as to affect its shape, and is then placed within an iron casing having internal projecting ribs so arranged as to hold the glass article in position and to touch it at the fewest possible points. The casing with its inclosure is cooled in the open air. The process is only applicable to articles of nearly uniform thickness throughout; it increases the strength of the glass about three times, and renders it less liable to be effected by changes of temperature than ordinary glass is.

The third kind of glass, which is known as *hard-cast glass*, has not yet been introduced commercially, but samples of the work produced in the form of sleepers, tramway-rails, grindstones, and floor-plates were exhibited at the meeting. The method of production is very simple.

[1] "On the Use of Polynomials and Names in Zoology." By S. Garman, Cambridge, Mass., U.S.A. From the *Proceedings* of the Boston Society of Natural History, March 19, 1884.

Glass made in a continuous glass-melting furnace is run into moulds as with iron castings. The only precaution that has to be taken is that the moulding material shall have as nearly as may be the same specific heat and the same conductivity for heat as glass. Various mixtures of materials that are easily obtainable and not costly are suitable, such as mixtures of powdered porcelain, glass pots, metal turnings and filings, and such minerals as heavy spar and magnetic iron ore. These are pulverised and mixed in certain proportions, and then moulded in the ordinary way. The glass being run into the mould, the mould and its contents are heated up together, and then cooled together, and, when cool, the mould is opened and the glass removed. Glass may thus be cast into forms which it would be impossible to produce otherwise. That glass may thus be manufactured of great homogeneity was proved by the clear ring of a large tuning-fork made of the material, and in the manner described. Mr. Siemens promises on a future occasion to bring this matter again before the Society of Arts, after the completion of the works which he is now erecting for the manufacture of glass according to the process last described. As regards the other processes, the manufacture has increased in six years from 600*l.* to 7000*l.*, and, considering the very cheap rate at which hard glass castings can be produced—viz. about 5*s.* 6*d.* a hundredweight—Mr. Siemens feels satisfied that a large business will be done, more particularly as they supply a want which is felt on all sides; and thinks that glass not being liable to oxidation, as soon as it could be depended upon as regards strength, it would be applied for purposes for which metals, stone, and porcelain have hitherto been used.

THE PHYSIOLOGICAL LABORATORY AND OXFORD MEDICAL TEACHING

[WE regret to learn that another attempt is being made to suppress physiological teaching at Oxford. The not-over-scrupulous foes of scientific teaching and research have, we understand, distributed manifestoes by thousands all over the country We hope, therefore, that the following statement will receive equally wide circulation. Scarcely any of the well-known men who have signed the statement are in any way connected with what is generally known as science; certainly not one of them would have signed it had there been the least suspicion that in the Oxford Laboratory there would be any approach to cruelty:—]

A decree to provide for the expenditure of the department of Physiology will be submitted to Convocation on Tuesday, March 10. The annual sum required for this purpose is 300*l.*, besides 200*l.* for the salary of the Demonstrator of Histology.

The arrangements for the organisation of a complete system of instruction in the subjects of the first B.M. Examination and of the first and second Professional Examinations of the Conjoint Board of the College of Physicians and of the College of Surgeons in London are in progress, and will soon be completed. The new Lecturer on Human Anatomy will very shortly be appointed, and the Physiological Laboratory will be completed and ready for occupation by the end of the summer; so that before next October the University will be in a position to undertake the teaching of Human Anatomy and Physiology. The arrangements for teaching the other subjects in which instruction is required by medical students are also in progress.

As, in accordance with the recent resolution of the Colleges of Physicians and Surgeons, Candidates who have satisfied the Oxford Examiners in Anatomy, Physiology, and the other subjects of the first and second Professional Examinations, will be exempted from further examination in these subjects, Members of the University will in future be able to complete their first two years of medical study without leaving Oxford.

The purpose for which the expenditure is required is instruction not research, and no experiments upon the living animal involving pain will be used for demonstration to students or instruction, with or without anæsthetics.

It is, however, intended by those who desire absolutely to prohibit such experiments in physiological inquiry, to oppose the decree for the maintenance of the laboratory. Energetic measures are being taken to this end. The rejection of the decree would involve fatal consequences as regards the above-mentioned scheme for the teaching of medical science. The University has already twice pronounced upon the issues now sought to be raised, by votes taken in unusually full Convocations on June 5, 1883, and February 5, 1884. We, therefore, trust that you will be good enough to attend and vote in favour of the Decree on March 10, at 2 p.m.

H. G. LIDDELL, Dean of Christ Church.
J. FRANCK BRIGHT, Master of University.
GEORGE C. BRODRICK, Warden of Merton.
J. P. LIGHTFOOT, Rector of Exeter College.
DAVID B. MONRO, Provost of Oriel.
JOHN R. MAGRATH, Provost of Queen's.
J. E. SEWELL, Warden of New College.
W. W. MERRY, Rector of Lincoln.
W. R. ANSON, Warden of All Souls.
E. H. CRADOCK, Principal of B.N.C.
T. FOWLER, President of Corpus.
J. PERCIVAL, President of Trinity.
H D. HARPER, Principal of Jesus College.
G. E. THORLEY, Warden of Wadham.
EDWARD S. TALBOT, Warden of Keble.
WILLIAM INCE, Regius Professor of Divinity.
H. W. ACLAND, Regius Professor of Medicine.
W. H. FREEMANTLE, Fellow of Balliol College.
JOHN CONROY, Christ Church
ALFRED ROBINSON, Fellow of New College.
T. HERBERT WARREN, Fellow of Magdalene College.
F. MAX MÜLLER, Corpus Professor of Comparative Philology.
BARTHOLOMEW PRICE, Sedleian Professor of Natural Philosophy.
HENRY NETTLESHIP, Corpus Professor of Latin.
JAMES LEGGE, Professor of Chinese.
J. EARLE, Professor of Anglo-Saxon.
JOHN RHYS, Professor of Celtic.
T. H. T. HOPKINS, Fellow of Magdalen.
W. LOCK, Fellow of Magdalen College, Sub-Warden of Keble College.
W. W. JACKSON, Fellow of Exeter, Censor of Non-Collegiate Students.
H. F. TOZER, Fellow and Tutor of Exeter.
A. G. BUTLER, Fellow and Tutor of Oriel.
AUBREY MOORE, Tutor of Keble and Magdalen.
ROBERT L. OTTLEY, Student of Christ Church.
W. MARKBY, Reader in Indian Law, Fellow and Tutor of Balliol College, and Fellow of All Souls' College.
H. F. PELHAM, Exeter College.

THE MAXIM GUN

MR. HIRAM STEVENS MAXIM, the well-known American engineer, has lately brought out a new form of a machine-gun, which is attracting a great deal of attention in military and naval circles. This gun is a completely new departure. It takes the cartridges out of the box in which they were originally packed, puts them into the barrel, fires them, and expels the empty cartridges, using, for this purpose, energy derived from the recoil of the barrel. Of course it is necessary to put the first cartridge into the barrel by hand. When, however, this is done, and the trigger pulled, the gun will go on and fire as long as there are any cartridges in the box.

The cartridges are placed in a belt formed of two bands of tape, before they are placed in the box, and one end of this belt is placed in the gun at the time of starting, the action of the gun drawing in one cartridge every time that one has exploded. The gun is really a veritable gunpowder-engine, the recoil of the barrel, the block, and the lock corresponding to the piston and cross-head of the engine. The recoil drives the barrel and its attachments backwards, opens the breech, cocks the hammer, and expels the empty shell. The return of the block is effected by a spring. As the bolt returns, it forces a loaded cartridge into the barrel and pulls the trigger.

It would naturally be supposed that a gun which loads and fires itself would be somewhat complicated. This, however, is not the case when the gun is considered simply as a self-loading gun. The additional parts which form a part of Mr. Maxim's new gun are due rather to the mode of feeding than to the fact that the gun is automatic. It is certainly a very great advantage to have the gun supplied from a very large magazine from below.

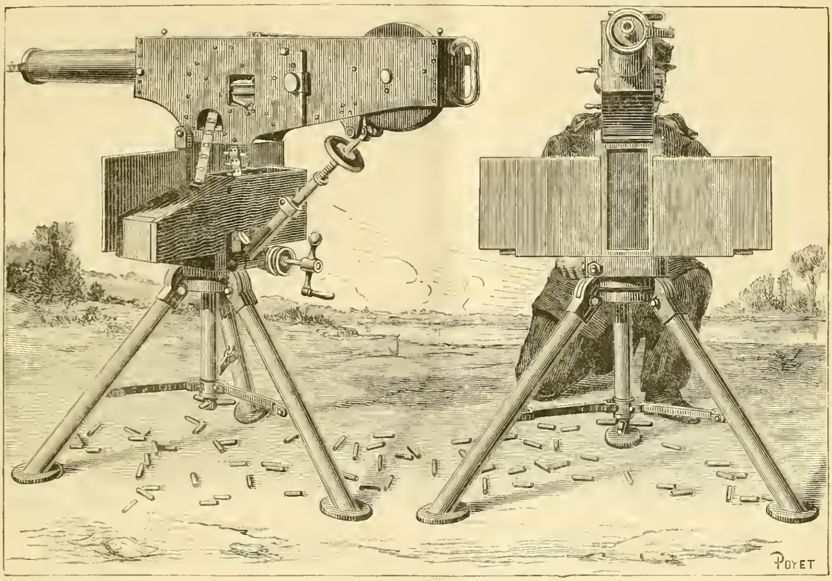


FIG. 1.—Maxim Mitrailleuse. Lateral elevation and front view.

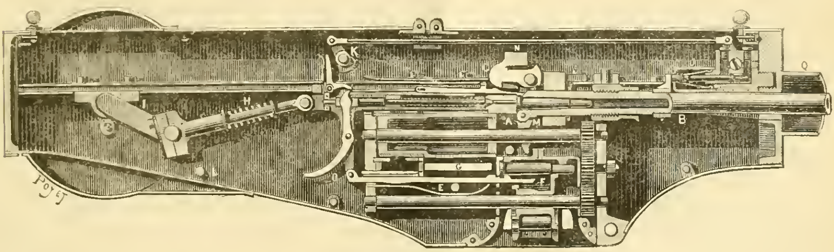


FIG. 2.—Section of the mechanism.

If, however, the magazine should be placed on top of this new arm, as it is in other machine guns, and be small in size and depend upon gravity to bring the cartridges into their respective places, the gun would be quite as simple as any existing guns.

The rapidity of fire in this gun is regulated by a cataract chamber, and the gun may be fired at any speed from one round per minute up to 600 per minute for guns of rifle calibre and slower for larger sizes.

This gun possesses many advantages over existing types of machine-guns, among which may be mentioned the following :—

As it furnishes its own power, it does not require to be firmly fixed upon its platform as other guns do, so that it is quite free to move in any direction while being fired.

Cartridges which hang fire, and which have proved so disastrous to other forms of machine guns, do not present any obstacle to the operation of this arm. As each par-

ticular cartridge depends upon its own power to withdraw itself from the barrel, it will be obvious that the cartridge cannot remove itself from the barrel before it explodes.

A gun which loads and fires itself is certainly a novelty, and presents many interesting features and possibilities to any one who takes an interest in implements of warfare.

The gun may be trained in any direction by turning the crank which operates a tangent screw, the stem of which projects from the platform immediately below the cartridge box seen on the top of the tripod, whilst a fine adjustment in elevating may be obtained by turning the small hand wheel, which forms a part of the diagonal telescopic brace which supports the rear of the gun. By loosening the three-handled screw immediately below the central standard, the gun may be turned completely round, and by loosening the thumb screw of the telescopic brace, the gun is absolutely free to be moved up or down or in any direction while firing. If, however, it is desired to have a definite stop to the horizontal play of the gun, as, for instance, when firing upon a bridge, a pass, or a ford, or upon earthworks, the gun may be sighted between the two points, and adjusted by the thumb nuts on the tangent screw stem, when the gun will be free to operate between these two points, but will not go beyond them. Fig. 1 is a perspective view of the gun. Fig. 2 is a longitudinal central section of the weapon. A is the block or bolt which slides freely after the manner of the cross head of a steam-engine; B is the barrel; C the locking device for securing the block to the barrel at the instance of discharge; D is the cocking lever; E, the carrier which draws the cartridges out of the belt and deposits them in the feed wheel G; F is the belt wheel which draws the belt of cartridges into the gun; H is a connecting rod made slightly elastic by being provided with a strong spring; I is a crank which does not, however, turn completely round; L is a point of resistance, against which the cocking-lever, D, strikes at each rearward motion of the block; K is a shaft connected with the trigger, which operates upon the sear and also upon the controlling chamber J; M is the extractor which starts the cartridge from the barrel; N is a bar which holds the locking device C in position, and which raises it or unlocks it at each rearward motion of the barrel; O is a casing surrounding the barrel, which may be used, if desired, as a water jacket.

RORAIMA

OUR readers will be interested in reading the following letter, which has just been received at Kew, from Mr. im Thurn, in confirmation of his telegram already published (NATURE, vol. xxxi. p. 342), announcing his successful ascent of Roraima:—

Georgetown, February 4, 1885

I have just sent a most brief telegram (such things are expensive here) which will, I hope, give the first news that Roraima has been ascended; and I much wish I could write even a brief report to go by this mail, but ever since I have been back (we got back four days ago) I have been in bed with the most severe attack of fever and ague that ever befel me, and, though the doctor assures me that I have now turned the corner, I am so weak as to be quite unable to sit up. However, before next mail I must manage something. And in the meantime I send a local paper which purports to give an account of the expedition derived from myself. The main facts are tolerably correct, but the details are much blurred.

We were quite successful in getting to the top, and have found that the plateau is by no means the isolated spot it has sometimes been supposed to be. It was, however, a great disappointment that, our way up being so extremely laborious, it would be quite impossible, without a very large expenditure in somewhat smoothing the path, to carry up hammocks, &c., provisions, and firewood (for there are no trees on the top and it is bitterly cold)—it was a great disappointment, I say, that we could only explore the top for a short distance from the point which we first reached. I see, however, no reason to believe but that the whole top is of one character. The scenery is in the highest degree wonderful. I made many fairly successful sketches (considering I am no artist), which will give a very fair idea of the mountain and of the scenery on the top. As I wish to keep the original sketches for the present, to copy them at my leisure, I have just handed the half-dozen most characteristic amongst them to a photographer here, who has before been fairly successful in copying drawings for me, and I hope to send you copies by next mail. The vegetation (on the top) is most wonderful, but somewhat scanty and quite dwarf. I have between 300 and 400 species for you. I have also some living plants (*Heliamphora*, three most exquisite Utricularias, two of which are, I fancy, new; and a few other things), but, as these want much nursing, I have put them into wardian cases, and shall take them home for the present. (I miss Jenman now, and have throughout the expedition, immensely.)

Yours very truly,
(Signed) EVERARD F. IM THURN

NOTES

AT the moment of going to press we have received from Sir E. J. Reed a communication protesting against some of the statements made in our article last week on "The Relative Efficiency of War-Ships," and pointing out that the system of construction advocated by him was greatly modified during the ships' progress. So far from wishing to deal unfairly with Sir E. J. Reed's views, one of our chief objects was to support his protest against the existing state of things, by suggesting that scientific experiments should be resorted to to settle some of the questions on which doubts have been expressed by contending authorities.

WE regret to learn that M. Milne-Edwards is lying in a precarious condition.

OUR readers will regret to learn that Prof. Bonney will resign his post as secretary of the British Association after the Aberdeen meeting. Prof. Bonney, we believe, feels compelled to take this step mainly on account of the inroads which the work of the Association makes upon his time. No one will regret his retirement more than the council and his fellow officials.

M. BOUQUET DE LA GRYE has received a mission from the French Minister of Public Instruction to proceed to Teneriffe in order to study the variations of gravitation according to altitude.

WE have received from the Royal Society of Public Medicine of Belgium its recent monthly tables. With the present year it assumes a new field of usefulness. Founded originally in 1876, it was composed of men who by their position or special knowledge were able to participate (1) in determining the cause of mortality in general, and the circumstances which affect public health; (2) in informing and assisting the authorities by special studies and researches; (3) in preparing the medical topography of Belgium; and (4) in discussing at annual public meetings questions presently relating to this work. The Society is formed of eleven local subdivisions, each sending a number of members to form the general council. But in addition to these subdivisions, for administrative purposes, the Society is also divided for the scientific service into a number of zones limited according to the physical nature of the districts. The medical topography of the kingdom, and all questions relating to it, are studied according to these zones. During last year the Society made a

systematic inquiry into the sanitary situation of the country, which was highly approved of at the Health Exhibition in London, and now it has been determined to continue the investigations on a systematic and permanent basis. The members of the Society scattered over Belgium are called on to assist in the new undertaking, and the specimen forms which they are required to fill in monthly are now before us. There are thirteen zones, each zone being subdivided into districts. The physicians who are members of the Society, or who are willing to participate in its labours, are requested to state the diseases of which patients in their practice have died during the month. From these various reports a general statement, and tables of relative statistics are issued by the central body. In course of time a medical topography of the country, the enormous public advantages of which are apparent, will be issued.

THE *Transactions* of the Seismological Society of Japan for 1884 (vol. vii. part 2) contains a paper, by Prof. Milne, on 387 earthquakes observed during two years in North Japan. To determine the extent of country over which an earthquake was felt, he distributed bundles of post-cards to the Government officials at all important towns within a distance of 100 miles of Tokio, with a request that every week one of the cards should be posted with a note of any earthquakes that might have occurred. By this expedient it was discovered that the Hakme Mountains to the south of the Tokio plain appeared to stop every shock coming from the north, and accordingly the barrier of post-cards was stopped in that direction, but was extended gradually to the north until it included the forty-five principal towns in the main island to the north of Tokio, besides several places in Yezo. In Tokio, observations as to direction, velocity, and intensity were made with various earthquake instruments. A description of the principal instruments used, with a comparison of their relative merits, has already been given by Prof. Milne in vol. iv. of the *Transactions* of the Society. The second part of the paper is devoted to a list of the 387 earthquakes recorded, with particulars of each; 124 maps of earthquake districts, as well as numerous other illustrations, are appended. The results of an exhaustive study of these earthquakes may be summed up as follows:—(1) As to distribution in space: of the 387 shocks, 254 were local, that is, they were not felt over an area greater than 50 square miles; 198 of these were confined to the seaboard, and 56 were inland. The average diameter of the land surface over which the remaining 133 extended was about 45 miles, but four or five of them embraced a land area of about 44,000 square miles. These great shocks originated far out at sea, and consequently were not so alarming in their character as many which originated nearer to or beneath the land. (2) Simultaneous shocks: some of the disturbances took place at areas remote from each other, whilst intermediate stations did not record them. (3) Origins of earthquakes: the general result under this head is that the greater number of earthquakes felt in Northern Japan originated beneath the ocean; 84 per cent. of the whole having so originated. The district which is most shaken is the flat alluvial plain around Tokio. Indeed, the large number of earthquakes felt in low ground as compared with the small number felt in the mountains is very remarkable. It is also noticeable that in the immediate vicinity of active or recent volcanoes seismic activity has been small. The map marking the general distribution of volcanoes and the regions of the greatest seismic activity shows that these are not directly related to each other. The district, too, where earthquakes are the most numerous, is one of recent and rapid elevation, and it slopes down steeply beneath an ocean which, at 120 miles from the coast, has a depth of about 2000 fathoms, whilst on the other side of the country, where earthquakes are comparatively rare, at the same distance from the shore the depth is only about 120 fathoms. In these respects the seismic regions of Japan resemble those of South America, where the earthquakes also originate beneath a deep ocean, at the foot of a steep slope, on the upper parts of which there are numerous volcanic vents, whilst on the side of this ridge opposite to the ocean earthquakes are rare. (4) Relation of earthquakes to various natural phenomena: the preponderance of shocks in winter, as revealed by this investigation, is really remarkable; 278 took place in the winter months, as against 109 in the summer, and of the former number, 195, or more than half of the whole number for the two years, took place in the three coldest months of the year—viz. January, February, and March, in other words, there is a general coincidence between the maximum of earthquakes and the minimum of temperatures. But the relation of seismic *intensity* (as distinct from the number of earthquakes) is even more remarkable, for the figures show that the winter intensity is nearly three and a half times as great as the summer intensity. M. Perrey thought he discovered a maximum of earthquakes for the moon's perigee, but no such maximum has been found for Japan. Speaking generally, no marked coincidence was found in the present instance in the occurrence of earthquakes and the phases of the moon. The above are the general results, stated briefly, of the most exhaustive and remarkable study yet undertaken in the domain of seismology.

La Nature contains a long report on the Andalusian earthquakes, from the pen of M. Noguès, a mining engineer of Granada, which, as being the first scientific investigation of the catastrophe, is worthy of special notice. The whole movement presented three phases. The first manifested itself, prior to December 25, at Pontevedra, Vigo, and in Portugal; in other words, in the eastern part of the Iberian peninsula. The second was very short and intense, and made itself felt in the centre and south; it reached its maximum intensity on the night of December 25. The third phase lasts still in the provinces of Granada and Malaga, and extended east to Valencia. The oscillatory movement of December 25 embraced a considerable superficial extent. The disturbed area in the peninsula is comprised between Cadiz and Cape Gaeta, between Malaga and the Carpetena chain. The movement became more and more intense as it left this mountainous mass and travelled in a southerly direction, until it attained its maximum in the region between the Serrania de Ronda and the Sierra Nevada of Granada. The oscillatory motion was gradually accentuated towards the south, especially on the southern side of the great central Spanish plateau, bounded by the slope of the valley of the Guadalquivir (Seville, Cordova, Malaga, and Granada). M. Garcia Alvarez localises the phenomenon in Andalusia, and regards the Sierra Nevada as the point of departure. M. Noguès then deals in succession with the relations between the seismic motions and the geological structure of the district, the geological phenomena, such as fissures in the earth, produced by the earthquakes, and alterations caused by them in the level of springs. He sums up his conclusions by pointing out that the geological observations which have been made so far, although local, limited, and imperfect, demonstrate that there were two different kinds of motions—one oscillatory, the other a trembling movement. Every one who felt the great earthquake of the 25th experienced first a vertical shock, and then, after a short interval, another movement like a balancing. A great fissure at the village of Guevejar presents at two points two interesting sections. At one the trunk of an olive-tree has been split in two from its root to the branches, as if from a blow of a hatchet, each part occupying a side of the fissure, one on one side, the other on the other. At another part the fissure has divided in two the wall supporting the wheel of the powder-factory at Guevejar. The cracks in the houses in the village are in lines parallel to these fissures, and the marks left in the soil

indicate an oscillatory motion. The chimneys, in many cases, were turned half around on their axes, without any further disturbance of a single portion of the structure; and, in fact, an examination of the various marks left by the earthquake of December 25 places it beyond doubt that there was a trembling as well as an oscillatory movement.

On Wednesday evening last week, at half-past eight, three heavy shocks of earthquake, lasting for two seconds, and passing from west to east, were felt at Temesvar, in Southern Hungary. On Thursday morning there was another and slighter shock. Two sharp shocks were felt on Friday in Spain, most severely in Granada, Loja, Alhama, and other districts on both sides of the Sierra Tejea. In the Provinces of Granada and Malaga many houses were damaged, and buildings that had suffered in the previous earthquake were now knocked down.

The last number of the *Bulletin* of the Essex Institute (Salem, July to December, 1884) is of especial interest, as it contains the proceedings held in commemoration of the fiftieth anniversary of the foundation of the Essex County Natural History Society, of which the Institute is the natural heir and successor. The papers which were read were all appropriate to the occasion. Prof. Morse dealt with the condition of zoology fifty years ago and now, in connection with the growth of the Institute. Mr. Robinson discussed the progress of botany in Essex county during the half-century, and the influence of the Society on it, dividing his paper into three parts: (1) The condition of botanical knowledge now as compared with fifty years ago; (2) the progress made in that period in the district, as shown by the increase of libraries, public museums, private herbaria, &c.; and (3) the practical benefit and general knowledge bestowed upon the people of the county by such increased accurate knowledge of the subject and the facilities for obtaining it. It would be impossible to sum up more clearly and thoroughly, from all points of view, the benefits of such societies as the Essex Institute to their localities and to the progress of science in general than is done in this paper. Mr. McDaniel deals with geology and mineralogy, in which the work has not been so great as in botany, zoology, and prehistoric archæology, "owing to the bent and profession of the leading members." The commemoration papers conclude with a brief historical sketch by Mr. Samuel Fowler, who notices as evidence of the liberality of the founders of the Society that, though nothing was heard of women's rights fifty years ago, they invited ladies to join them, adding in their circular: "It is anticipated that they will contribute much to the success of the Society." The historiographer is able to add that these anticipations were realised, for "ladies have always taken a deep interest in the Society and its work, and have greatly aided us in many ways." The result of this "stock-taking" after half a century is a legitimate source of pride to the inhabitants of the good old town of Salem and its neighbourhood.

It will interest many of our readers to know that an Exhibition of Photographs by Amateurs will be held at 103, New Bond Street, from April 23 to May 9, under the auspices of the "London Stereoscopic Company." This, as far as we know, will be the first of its kind, and will doubtless be patronised by a large number of exhibitors, and tend to encourage the growing popularity of photography amongst amateurs. Several photographs by the late Mr. Cameron, of the *Standard*, will form an interesting feature of the Exhibition. Prizes to the value of 200*l*. will be awarded. Intending exhibitors are requested to communicate with Mr. T. C. Hepworth, at 108, Regent Street, W.

The popular Chinese practice and superstition with regard to persons in an epileptic fit are not a little curious. When a person gets an attack of epilepsy, those about him rush away for a few blades of grass, which they put into his mouth. They believe that during an attack of epilepsy the spirit leaves the body, and, there being a vacancy within, it is immediately filled by the spirit of an animal, generally a sheep or a pig, and the sound in the person's throat as he begins to revive is taken for the bleating of the one or the grunting of the other. Under these circumstances they attempt to propitiate the animal by putting grass into the man's mouth, possibly under the impression that they can entice the animal's spirit in the man to remain till his own returns; and on no consideration will they remove him till the fit is over, for, if they did, they believe his own spirit would not be able to find him again, and thus he would die.

Messrs. W. Swan Sonnenschein & Co. will shortly publish a translation, by Prof. Hillhouse, M.A., of the Mason Science College, of Strasburger's "Das kleine botanische Practicum."

The next Ordinary General Meeting of the Institution of Mechanical Engineers will be held on Friday, March 20, at 25, Great George Street, Westminster. The chair will be taken at 7.30 p.m. by the President, Mr. Jeremiah Head. The following papers will be read and discussed, as far as time will admit:—On recent improvements in wood-cutting machinery, by Mr. George Richards, of Manchester (adjourned discussion); description of the tower spherical engine, by Mr. R. Hammersley Heenan, of Manchester; on the history of paddle-wheel steam navigation, by Mr. Henry Sandham, of London.

The Annual Report of the Belfast Naturalists' Field Club is a respectable volume of about 260 pages, with twenty-four plates containing about fifty illustrations, devoted in the present number wholly to cromlechs and other prehistoric remains in the north and west of Ireland. The Society has attained its majority (the past year being its twenty-first), and the secretary is able to report that it was never more prosperous, either as regards increased membership, financial condition, or the value of the work done. Among the papers read during the winter session we notice: on the antiquities of the West of Ireland, on a microscopical examination of a bit of groundsel, Magilligan strand after a storm (in which Canon Grainger describes the castaways after a gale), ants, a trip to America, the age of the basalts of the North-East Atlantic (by Mr. J. Starkie Gardner), while the appendix contains three longer papers:—Notes on Irish coleoptera, by Messrs. Hallilay and Stewart; the cromlechs of Antrim and Down, by Mr. Gray; and notes on prehistoric monuments at Carrowmore, near Sligo, by Mr. Elcock. It is to the two last that the numerous illustrations are attached.

M. Waldemar Czerniawsky, already known for his works on the fauna of the Black Sea, has now published at Kharkoff a work on the "Crustacea decapoda Pontica littoralia," accompanied by several plates, being a very elaborate description of the Black Sea Decapods. The number of Pontic species of Decapods has been increased by twenty, reaching thus forty-eight species, with numerous varieties, though it will probably be greater when the depths of the Black Sea have been better explored. The results of this work are numerous and interesting. The species offer altogether a very great variety of forms. The Black Sea contains the local forms of Mediterranean varieties, while in the Celtic region are found the local forms of other varieties. The author asserts that the metamorphosis of the superior crabs, such as *Carcinus*, which presents nine different stages, are a repetition of their genealogy, and arrives at a series of very interesting conclusions as to the genealogy of different species. All three species of *Astacus* which are found in the Ponto-Caspian fauna are maritime forms which have immigrated

into sweet water, and even the *Astacus pachypus*, Rathke, of the mountain-lake Abrau, is a remainder of a maritime fauna; so also *Thelphusa*, which has gigantic representatives in the South Caspian. Certain crabs reach really gigantic size in the Ponto-Caspian region; such as *Eriphia spinifrons* and *Carcinus mænas* on the shores of Crimea and at Odessa. While most crabs reach a great development only in very salt and warm water, others reach the same size under the influence of reverse conditions. The Decapods of the Azov Sea have not yet been explored. The descriptions of the species and their varieties being given in Latin, as also the explanations to the plates, the work is rendered accessible to all zoologists, many of whom, however, will regret not to be able to understand the notes (mostly zoo-topographical, and sometimes adding minor details to the description), which are in Russian.

WE have received from the Johns Hopkins University the two last of the Studies on Historical and Political Science. One deals with land laws in mining districts, and describes the regulations for the use of land made by agreement among the miners themselves in the Western States. They show a return to primitive ideas, where use is made the proof of ownership, and equality in the size of the various lots is of prime importance. Mr. Shinn is the author of this number. The second, by the editor, Dr. Adams, describes the influence of the State of Maryland upon the land cessions of the United States, and is specially interesting for its references to Washington's project for devoting the present made to him by his native State, Virginia, to the establishment of a National University.

WITH the exception of a few pages, the whole of the last number (vol. vi. No. 4) of the *Boletin de la Academia Nacional de Ciencias* of Cordova (Argentine Republic) is occupied by a paper by M. Oscar Dœring on meteorological observations made by him at Cordova during 1883. These were a continuation of those made by him in 1882 on evaporation, and the various temperatures at six different depths. But for 1883 he has added other observations and arranged the tables as follows:—Atmospheric pressure, temperature of the air, the elastic force of the atmospheric vapour, relative humidity, evaporation in the shade and in the sun, temperature of the soil, solar radiation, storms, and rainfall. There is also a short paper on the observations of the German expedition to Bahia Blanca, to observe the transit of Venus.

THE additions to the Zoological Society's Gardens during the past week include two Wood Hares (*Lepus sylvaticus*) from North America, presented by Mr. F. J. Thompson; an Alexandrine Parrakeet (*Palæornis alexandri* ♀) from India, presented by Mr. W. Hay; a Common Magpie (*Pica rustica*), British, presented by Mr. H. Clare; a Slowworm (*Anguis fragilis*), British, presented by Mr. R. Gunter; a Short-tailed Wallaby (*Halmaturus brachyurus*) from Western Australia, deposited; two Brown Pelicans (*Pelecanus fuscus*) from the West Indies, purchased; an Isabelline Lynx (*Felis isabellina* ♂) from Tibet, received in exchange, two Spotted Ichneumons (*Herpestes nepalensis*) from Assam, received on approval.

OUR ASTRONOMICAL COLUMN

A COMET IN 1717.—In a note to the Royal Society (*Phil. Trans.*, No. 354) Halley reported that on Monday, June 10, 1717, in the evening, the sky being very serene and calm, he was desirous of examining Mars, then very near the earth, to ascertain whether in his 20-foot telescope he could distinguish the spot said to be seen upon his disk, and directing his telescope for that purpose he accidentally met with a small whitish appearance near the planet, which seemed to emit from its upper part a short kind of radiation, directed nearly towards the point opposite to the sun. The great light of the moon, then not far from full, and close at hand, hindered the object from being distinctly seen, but he determined its place to be nearly in 17° 12′ of Sagittarius with 4° 12′ south latitude. The position, he adds, would be more exactly found by means of two small stars near it, the more northerly of which had the same latitude and followed at the distance of about six minutes; the other was about four minutes south of the former, and followed it about a minute, "the angle at the northern star was somewhat obtuse, of about 100 degrees, and the distance of the nebula from it was sesquialteral to the distance of the two stars, or rather a little more." No motion being detected in over one hour, Halley doubted if it were a comet, but on June 15, the moon being down and the sky clear, he had a distinct view of the two stars, but there was no sign of the nebulosity where it had been observed on June 10. He was led by this circumstance to remark upon the number of comets which might escape notice, from their being telescopic objects, and adds that, although comets had been seen elsewhere in 1698, 1699, 1702, and 1707, he could not learn that any comet had been perceived in this country for the thirty-five years previous to the observation above described, which implies that none had been seen here since the year 1682, that of the appearance of the famous comet which bears Halley's name.

The small stars to which Halley refers would appear to be Nos. 16,627 and 16,631 in Oeltzen's Argelander.

THE VARIABLE STAR S CANCRI.—A minimum of this short-period variable being due during the night of February 20, Mr. Knott availed himself of a fine sky at Cuckfield to observe it as long as it was possible to do so. The watch commenced at 8h. 40m., and ended at 17h. 15m. At 9h. 23m. no change was noticeable, but soon after 9h. 30m. the star began to decline, and gradually fell from 8·1 to 10·4 mag., which point was reached about 15h. 30m. From that time till 17h. 15m. no certain change was detected, though at 17h. 15m. there was a suspicion of the star being possibly a trifle brighter. By this time it was 17h. past the meridian, and getting too low for observation. As it was not possible to follow the star till its advance on the rising curve, Mr. Knott was unable to fix the time of minimum with certainty, but considered the predicted time (16h. 22m.) was pretty correct. He remarks further that Prof. Schönfeld gives 8½h. as the time of decrease, and 13h. as that of increase. If this held for the minimum of February 20, and the decrease began at 9h. 30m., the minimum would not be reached before 18h., and the normal magnitude would not be attained before February 21, 8h. At 6h. 30m. on the latter date he doubted whether the star had recovered its normal brightness, but by 7h. or 7h. 30m. there seemed no doubt about it. Comparing the form of his curve with Prof. Schönfeld's, it appeared that on this occasion the star was longer in falling from 9·4 and 9·9 m. to the lowest point reached, than the observations of Prof. Schönfeld indicated; but Mr. Knott writes doubtfully upon this point, not having previously watched S Cancri through its changes. The next minimum may be expected on March 11, between 15h. and 16h. Greenwich time.

THE MELBOURNE OBSERVATORY.—We have received the nineteenth annual report of the Government Astronomer of Victoria to the Board of Visitors of the Melbourne Observatory. The new transit circle of 8 inches aperture, constructed for that establishment by Mr. Simms, was received in May last, and the mounting was completed early in July. At the time of drawing up the report (August, 1884) there were only wanting some steps and observing chairs, for the instrument to be brought into regular use. It is stated to be very similar in form and dimensions to the transit circles constructed by the same firm for the observatory at Cambridge and for that of Harvard College, U.S. The great reflector was in better condition than at the date of the previous report, nevertheless it is proposed to send the two specula, one after the other, to England, to be repolished. A number of stars selected by Prof. Auwers had been observed with the old transit circle, to assist in the formation of a fundamental catalogue of southern stars. Mr. Ellery mentions those of Herschel's nebulæ, which had been observed, and of which drawings had been made with the great telescope; the nebula of η Argûs, 30 Doradus, and the "Horseshoe" nebula are included in his list. Pons' comet was observed for position from January 6 to March 18. The completion of the telegraphic determination of Australian longitudes, it is reported, was only waiting a new series of exchanges between Sydney, Adelaide, and Melbourne; New Zealand had been connected with Sydney by a most successful set of time-exchanges through the cable. The connection of Brisbane

and Sydney was in progress, and, on this being completed, there would only remain to connect Western Australia, to have the longitudes of all the chief Australian and New Zealand cities and ports determined upon the same system.

Mr. Ellery recommends that a small expedition should be despatched from Melbourne to New Zealand for the observation of the total eclipse of the sun on September 9 in the present year, when the central line passes through Cook's Straits. Sir W. Jervois, the Governor of New Zealand, had promised all the aid he could render in the matter. The Board of Visitors supported an application to the Government of Victoria for the necessary funds. [Full details of the circumstances of this eclipse were given by Mr. Hind in the *Monthly Notices* of the Royal Astronomical Society for January last.]

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *MARCH* 8–14

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 8

Sun rises, 6h. 31m.; souths, 12h. 10m. 51·6s.; sets, 17h. 51m.; decl. on meridian, 4° 42′ S.: Sidereal Time at Sunset, 4h. 57m.

Moon (at Last Quarter at 19h.) rises, 1h. 5m.; souths, 5h. 40m.; sets, 10h. 12m.; decl. on meridian, 17° 25′ S.

Planet	Rises	Souths	Sets	Decl. on Meridian
	h. m.	h. m.	h. m.	° ′
Mercury ...	6 36 ...	11 56 ...	17 18 ...	8 22 S.
Venus ...	6 13 ...	11 18 ...	16 23 ...	11 26 S.
Mars ...	6 28 ...	11 52 ...	17 16 ...	7 44 S.
Jupiter ...	15 46 ...	22 58 ...	6 10* ...	13 8 N.
Saturn ...	9 56 ...	18 0 ...	2 5* ...	21 41 N.

* Indicates that the setting is that of the following nominal day.

Occultations of Stars by the Moon

March	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
10 ...	B.A.C. 6287 ...	6 ...	4 25 ...	5 38 ...	90 228
10 ...	B.A.C. 6292 ...	6 ...	5 6 ...	6 26 ...	54 280
11 ...	ρ' Sagittarii ...	4 ...	5 18 ...	6 38 ...	60 272

Phenomena of Jupiter's Satellites

March	h. m		March	h. m.	
8 ...	2 46	II. ecl. reap.	13 ...	0 27	I. occ. disap.
	6 12	IV. occ. disap.		3 14	I. ecl. reap.
9 ...	20 8	II. tr. egr.		19 1	III. tr. ing.
10 ...	5 23	III. occ. disap.		21 45	I. tr. ing.
11 ...	6 0	I. occ. disap.		22 39	III. tr. egr.
12 ...	3 19	I. tr. ing.	14 ..	0 5	I. tr. egr.
	5 38	I. tr. egr.		18 53	I. occ. disap.
				21 43	I. ecl. reap.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such s are visible at Greenwich.

March 13, 19h.—Mercury in superior conjunction with the Sun.

RECENT ENGINEERING PATENTS [1]

SIR FREDERICK BRAMWELL stated that he had been determined in his choice of a subject by the consideration that H.R.H. the Prince of Wales had seen fit to appoint him chairman of the Executive Council of the International Inventions Exhibition, to be held at South Kensington this year. He therefore proposed to direct attention to some of those objects that ought to be contributed to that Exhibition which were more particularly connected with civil engineering.

Dealing, first, with materials of construction, the President remarked that probably few materials had been more generally useful to the civil engineer, in works which were not of metal, than Portland cement. During the last twenty-two years great improvements had been made in the grinding and in the quality of the cement. As regards bricks, although not now superior in quality to those made by the Romans, there was progress to be noted in the mode of manufacture and the materials employed. The brick-making machine and the Hofmann kiln had economised labour and fuel, while attempts were being made to utilise the waste of slate quarries. Certain artificial stones appeared at last to be produced with such a uniformity and power of endurance as to compare favourably with the best natural stone, or were even better, for they could be produced of the desired dimensions and shape, and were thus ready for use, without labour of preparation. The employment of wood, except in newly-developed countries, was decreasing, for one reason, because it was practically impossible so to use it as to obtain anything approaching to the full tensile strength. Many attempts had been made to render timber proof against rapid decay and ready ignition, and it was in these directions alone that progress could be looked for. With respect to preservation from fire, the wooden structures of the Health Exhibition were coated with asbestos paint, and to this their escope from destruction by a fire was due. Leaving the old-world materials of stone and wood, attention was directed to that form of iron known as steel. The President remarked that, in his judgment, the making of steel in crucibles was not so satisfactory a mode of obtaining uniformity in large masses as was either of the other two great systems of manufacture—the Bessemer and the Siemens—the two processes which had changed the whole complexion of the iron industry. He further said that, eight years ago, in a lecture he delivered at the Royal Institution, he had ventured to predict that steel made by fusion would supersede iron made by the puddling process, and that the use of iron so made would be restricted to the small articles produced by the village blacksmith. The first important revelation in steel manufacture was the ingots shown by Krupp, with other products, in the Great Exhibition of 1851. These showed an enormous step at the time when the production of steel involved the employment of the crucible. Within the last eight years a great improvement had been made by Messrs. Thomas and Gilchrist, by which it had been rendered possible to employ successfully, in the production of steel, iron derived from ores that, prior to the date of this invention, had been found wholly inapplicable for the purpose. In the manufacture of pig-iron improvement had been effected by increasing the dimensions of the furnaces and the temperature of the blast, by the better application of chemistry to the industry, by the total closing of the bottom of the furnace, and by the greater use of the waste gases. Copper, so long used in its alloyed condition of "gun-metal," had, within the last few years, been still further improved by alloying it with other substances so as to produce "phosphor-bronze" and "manganese-bronze," very useful materials to those engaged in the construction of machinery. With the increased dimensions of the main-shafts of engines, and of the solid forgings for the tubes of cannon, obtaining at the present day, composed, as they were, of steel, the operations of light steam-hammers were absolutely harmful, and the blows of even the heaviest hammers were not so efficacious as was pressure applied without blow. The time was not far distant when all steel in its molten state would be subjected to presusre, with the object of diminishing the size of any cavities containing imprisoned gases.

Within the period under consideration the employment of testing-machines had come into the daily practice of the engineer, for determining, experimentally, the various physical properties of materials—and of those materials when assembled into forms to resist strain, as in columns or in girders.

In those matters which might be said to involve the principles of engineering construction, there must of necessity be but little progress to note. Principles were generally very soon determined, and progress ensued, not by additions to the principles, but by improvement in the method of giving to those principles a practical shape, or by combining in one structure principles of construction which had hitherto been used apart.

Taking up, first, the subject of bridge construction—the President thought the St. Louis bridge might fairly be said to embody a principle, novel since 1862, that of employing for the arch ribs tubes composed of steel staves hooped together. Further, in suspension bridges, there had been introduced the light upper chain, from which were suspended the linked truss-rods, doing the actual work of supporting the load, the rods being maintained in straight lines, and without flexure at their joints due to their weight. In the East River Bridge at New York, the wire cables were not made as untwisted cables, and then hoisted into place, imposing severe strains upon many of the wires, but the individual wires were led over from side to side, each having

[1] Abstract of Presidential Address at the Institution of Civil Engineers, by Sir Frederick J. Bramwell, F.R.S., on January 13.

the same initial strain. So far as novelty in girder-construction was concerned, the suspended cantilever of the Forth Bridge, now in course of construction, afforded the most notable instance. It was difficult to see how a rigid bridge, with 1700 feet spans, and with the necessity for so much clear headway below, could have been devised without the application of this principle. A noteworthy example of the use of pneumatic appliances in cylinder-sinking for foundations was also in progress at the Forth Bridge. At the New Tay Viaduct, the cylinders were being sunk while being guided through wrought-iron pontoons, which were floated to their berths and were then secured at the desired spot by the protusion, hydraulically, of four legs, which bore upon the bottom, and they, until they were withdrawn, converted the pontoon from a floating into a fixed structure.

The President next traced the contest between canals and canalised rivers as modes of internal transit, in contrast with railways, and referred to the improved rate of transport on canals by the substitution of steam- for horse-haulage, and by a diminution in the number of lockages. He also alluded to the hydraulic canal lift on the River Weaver, and to a similar application in the Canal de Neufossé, in France, for overcoming a great difference of level, and reducing the consumption of water and the expenditure of time to a minimum. The great feature, however, of late years in canal engineering, was not the preservation, or improvement, of the ordinary internal canal, but the provision of canals such as the completed Suez Canal, the Panama Canal in course of construction, the contemplated Isthmus of Corinth canal—all for saving circuitous journeys in passing from one sea to another—or in the case of the Manchester Ship Canal, for taking ocean steamers many miles inland. The rivalry between canal-engineers and railway-engineers was illustrated by the proposal to connect the Atlantic and Pacific oceans by means of a ship-railway, the details of which scheme were before the public.

In harbour-construction, the principle adopted in the Liffey at Dublin was referred to, where cement-masonry was moulded into the form of the wall, for its whole height and thickness, and for such a length forward as could be admitted, having regard to the practical limit of the weight of the block. The block was then carried to its place, was lowered on to the bottom, which had been prepared to receive it, and was secured to the wall by groove and tongue. The apparatus by which the blocks, weighing 350 tons each, were raised, and transported to their destination, was then described.

Consideration of sub-aqueous works necessarily led to appliances for diving; and here the President said a few words about the "bateau-plongeur" used on the "barrage" of the Nile. Beyond improvement in detail and the application of the telephone, there was probably no novelty to record in the ordinary dress of the diver. But one great step had been made in the diver's art by the introduction of the chemical system of respiration. A perfectly portable apparatus had been devised, embracing a chemical filter by which the exhaled breath of the diver was deprived of its carbonic acid. The diver also carried a supply of compressed oxygen to be added to the remaining nitrogen, in substitution for that which had been burnt up in the process of respiration. Armed with this apparatus, a diver during one of the inundations which occurred in the construction of the Severn tunnel, descended into the heading, proceeded along it for some 330 yards (the depth of the water above him being 35 feet) and closed a sluice-door through which the water was entering the excavations, and thus enabled the pumps to unwater the tunnel. Altogether, this man was under water for one hour and twenty-five minutes without any communication with those above.

There were, happily, cases of sub-aqueous tunnelling where the water could be dealt with by ordinary pumping power, and where the material was capable of being cut by a tunnelling machine. In the Mersey Tunnel, in the New Red sandstone, a heading 7 feet 4 inches in diameter, a speed of 10 yards in 24 hours had been averaged, while a maximum of over 14 yards had been attained. In the experimental Channel Tunnel in a 7-feet heading in the gray chalk, a maximum speed of 24 yards had been arrived at in the 24 hours on the English side, and on the French side of 27⅓ yards in the same time. In ordinary land-tunnelling, since 1862, there had been great progress, by the substitution of dynamite, and preparations of a similar nature, for gunpowder, and by improvements in the rock-drills worked by compressed air, used in making the holes into which the explosive was charged. In boring for water, and for many other purposes, the diamond drill had proved of great service. Closely connected with tunnelling-machines were the machines for "getting" coal, which, worked by compressed air, reduced to a minimum the waste of coal, relieved the workman of a most fatiguing labour in a constrained position, and saved him from the danger to which he was exposed in the hand operation. The commercial failure of these machines was due to trade opposition, and it was to be feared that like prejudices would prevent the introduction of the lime-cartridge in lieu of gunpowder.

With regard to the great source of motive power—the steam-engine—it was difficult to point to any substantive novelty since 1862. But the machine had been more and more scientifically investigated, and the results had been practically applied with corresponding advantages. The increase in initial pressure, the greater range of expansion, the steam-jacketing of the vessels in which the expansion took place, had all led to economy. Double-cylinder non-condensing engines were now currently produced, which worked with a consumption of only 2¾ lbs. of coal per I.H.P., or 2·7 lbs. per H.P. delivered off the crank shaft, equal to 82 millions of duty on the Cornish-engine mode of computation. When these results were augmented by the employment of surface-condensation, an I.H.P. had been obtained for as low as 1⅓ lbs. of coal, and it was commonly obtained, in daily work, for from 2 lbs. to 2½ lbs. But in the use of steam as a heat-motor, the largest portion of the heat passed away unutilised. This defect had been sought to be overcome by a regenerative steam-engine, but it was not successful. Heated-air engines had hitherto only been found applicable where small power was required. Another form of heat-motor —the gas-engine—was daily coming into general use up to 30 I.H.P.. By a change in the mode of burning the mixture, and of utilising the heat thereby generated, the injurious shock of the early forms of gas-engine, and their large consumption of gas, were obviated. Comparing a gas-engine with a non-condensing steam-engine consuming 5 lbs. of coal per I.H.P. per hour, and demanding therefore, at one shilling per cwt., only one halfpenny for the purchase of coal, the extra cost for working the gas-engine was well repaid by the saving of boiler-space, of the wear and tear of the renewal of the boiler, of the consumption of coal while getting up steam and during meal-times, of the saving of wages, of the freedom from boiler explosions, and of the cessation of smoke production. A motor had been recently tried where no fuel was employed directly, but where a boiler, being filled with water and steam under pressure, had its heat maintained by exposing caustic soda, contained in a vessel surrounding the boiler, to the action of the waste steam from the engine, the result being that, as the moisture combined with the caustic soda, sufficient heat was developed to generate steam and keep the engine working for some time. Trials had been made with this motor for propelling a launch and for working a tramcar.

With respect to other motors, viz. those driven by wind or by water, in France an improvement had been made in water-wheels by which it was asserted that 85 per cent. of all the energy residing in a low fall of water had been converted into power. In turbines also there had been considerable development during the last twenty-two years, and they were very efficient where a high fall of water had to be utilised, or where, in the case of a low fall, great difference in the working head, and in the level of the tail-water, had to be provided for.

Next to the subject of motors came the transmission of power. In its restricted sense, the transmission from one part of a machine to another, reference might be made to the increasing use of multiple-rope driving-gear in lieu of belts, to inclined spur-gear for diminishing noise, and to that kind of frictional gearing to which the name of "nest-gearing" had been given. Where, however, the transmission was to long distances, means were being adopted for supplying power—*i.e.* water under pressure or compressed air—through mains laid down in the streets, in a manner similar to that in which gas and water were now supplied for domestic use; and in New York and other cities of the United States high-pressure steam was similarly conveyed and delivered to the consumers, both for power and for heating.

Sir Frederick Bramwell also remarked upon the continuous rolling of bars of steel for tyres, upon the right way of making boiler-shells and boiler-flues, upon tidal motors, upon "dirigible" balloons, upon the Maxim machine-gun, and upon the application of submarine mines and torpedoes for the defence of seaports. In regard to waterworks, he could not adduce any material improvements in those dependent upon storage, or in

pumping machinery; but in the matter of house-fittings there had been great progress, especially in the detection and prevention of waste of water. With respect to gas as a distributed illuminant, considerable improvements had lately been made, due to a greater liberality on the part of lighting-authorities, and to the use of multiple burners in street-lanterns, by which a greater amount of light was obtained from the same volume of gas. The regenerative gas-burners, and other modes, promised largely to increase the candle-power per cubic foot of gas burnt.

In conclusion, the President stated that, during his term of office, he would do all that lay in his power, as he had done in the past, to uphold the honour, the dignity, and the usefulness of the Institution; and in these efforts he felt satisfied that all the members would cheerfully and gladly assist.

HOW THOUGHT PRESENTS ITSELF AMONG THE PHENOMENA OF NATURE[1]

EVERY phenomenon which a human being can perceive may be traced by scientific investigation to motions going on in the world around him. This is obvious to every scientific man in regard to such phenomena as those of colour and sound, and these simpler cases were first adduced by the lecturer. He then pointed out that the statement is also true of all other material phenomena, and he specially dwelt on the phenomena investigated in the science of mechanics, showing that all the quantities treated of in that science, such as force and mass, prove, when the investigation is pushed far enough, to be expressible in terms of mere motion. He also showed that the prevalent conviction that motion cannot exist unless there is some "thing" to move will not stand examination. It proves to be a fallacious conviction traceable to the limited character of the experience of motions which we and our ancestry from the first dawn of organised thought on the earth have had within reach of our senses. This conviction accordingly has no authority with respect to molecular motions and to some others that have been brought to light by scientific study. He also showed that the "thing" which in common experience moves, proves in every case to be nothing else than these underlying molecular motions, the transference of which from place to place is the only kind of motion which common experience can reach, when unassisted by science.

The intermediate steps between the world external to our bodies and the brain which take place in our organs of sense and nerves can also be ascertained to be motions. And finally, a change consisting of motions takes place in the brain itself, whereupon we become conscious of thought: *i.e.* a change occurs within the brain which would be appreciated as motions by a bystander who could search into our brains while we are thinking, and could witness what is going on there, while all the time the change that we experience is thought. It must be borne in mind that our brain is a part of the external world to the bystander whom we have supposed to be observing what is going on in it. It thus appears that every phenomenon of the external world is reducible to motions and their modifications, while all that is within the mind is thought.

Now this motion to which all other material phenomena are reduced, this motion as it exists in nature, must be distinguished from man's conception of motion, which, after all, is one of his thoughts—a very complex one, no doubt, but not part of the external world. This particular conception in our minds is one remote effect of the motion as it exists outside us, and what we really know of that external cause is that it is a cause which does unfailingly produce this effect if the intermediate appliances of our senses and nerves are also present. Motion, the cause, must no doubt stand in absolutely rigorous relations to its effect, viz. our conception of motion: but it need not be like its effect, the presumption being quite the other way. The lecturer pointed out that, under these circumstances, the simplest and so far the most probable, hypothesis that can be advanced is the monistic hypothesis that this unknown cause is itself thought; and he pointed out that it is no objection to this view that we are unconscious of all the thought here supposed, for this is only to say that it is external to that particular group of interlacing and organised thoughts which we call our own mind, just as the thoughts of the many millions of our fellow-men and of all other animals are external to our little group.

[1] Short Abstract of Royal Institution Friday evening discourse (February 6), by G. Johnstone Stoney, M.A., D.Sc., F.R.S.

The lecturer accordingly recommended the following hypothesis: (1) as consistent with everything we know, (2) as the simplest hypothesis, (3) as an hypothesis which dispels all the difficulties that encumber the dualistic supposition that there are two kinds of existence, viz. the hypothesis that if a bystander were armed with adequate appliances to ascertain what is going on in our brain while we are thinking, then what we should experience to be thought is itself the remote cause with several intermediate causes of that change within the observer's brain which determines his having that complex thought which he would call perceiving some of the motions in our brain—in short, that what he appreciates as motion we experience to be thought.

If this view be correct, it will follow that the thoughts of which we are conscious are but a small part of the thought going on even in our own brain, and which would be seen by a beholder as motions, the rest being unconscious cerebration and as much outside our consciousness as are the thoughts of other people. We are led also to the conclusion that the thought which is going on in the brains of all the animals that exist is but the "small dust of the balance" compared with what is going on throughout the rest of the mighty universe.

SCIENTIFIC SERIALS

THE *American Journal of Science*, February.—Obituary notice of Benjamin Silliman, son of Benjamin Silliman, the founder of that *Journal*, and long one of its editors, who died in his sixty-ninth year at New Haven, Connecticut, on January 14, 1885.—The organisation and plan of the United States Geological Survey, with a map, by J. W. Powell. The organisation, as at present established, comprises: (1) an astronomic and computing division, the officers of which are engaged in determining the geographic coördinates of certain primary points; (2) a triangulation corps engaged in extending a system of triangulation over various portions of the country from measured base-lines; (3) a topographic corps, organised into twenty-seven parties scattered over various portions of the United States.—Memorial of the late distinguished botanist, George Bentham, by Asa Gray.—Palæontological notes on the material from the St. John group of New Brunswick contained in the Hartt Collection at Cornell University, by Charles D. Walcott.—On the rotation of the equipotential lines of an electric current by magnetic action, by E. H. Hall. The results are given of experiments made during the month of August, 1883, and at intervals since in the physical laboratory of Harvard College, the substances examined being chiefly copper, zinc, certain of their alloys, iron, and steel.—On the use of the term "Esker, or Kam drift," by J. Henry Kinahan. Both terms are traced to a Keltic source, *căm*, short (not *kāme*, long, as wrongly pronounced in England and the Lowlands), meaning, in Irish, *crooked* or *winding*, as in the river Cam, while *Eskir* or *Eiscir* denotes a small but well-defined ridge.—On the cause of mild polar climates, by James Croll. In this third paper the author discusses the climate of the Tertiary period in so far as affected by eccentricity, the evidence of climatic alterations and of glaciation during the same period.—Notice of the remarkable marine fauna occupying the outer banks of the southern coast of New England, by A. E. Verrill.—Note on a fossil coal plant found at the graphite deposit in mica schist at Worcester, Massachusetts, by Joseph H. Perry.—The test-well in the Carboniferous formation at Brownville, Nebraska, by Prof. L. E. Hicks.—Review of Hill's supplement to Delaunay's "Lunar Theory," by John N. Stockwell.

THE *Journal of Botany* for February contains a plate of several new or rare species of Desmid to illustrate one of a series of papers on these organisms, by Mr. W. Joshua. It contains also the annual list of new flowering plants published in periodicals in Britain in 1884. Most of the other articles are descriptive.

Bulletin de l'Académie Royale de Belgique, December, 1884.—On the microscopic intrusions of sagenite in the titaniferous oolitic hematite of the clay-slates, by A. F. Renard.—On the external branchial apertures of the Ascidians, and on the formation of the intestine in *Phallusia scabroides* (new species), by Edouard Van Beneden and Charles Julin.—On certain new animal organisms forming a local fauna peculiar to the neighbourhood of Thornton Bank, by Ed. Van Beneden.—On the presence of *Niphargus puteanus*, Sch., in the Liége district, by Ed. Van Beneden.—Action of high pressure on the vitality of

yeast, and on the phenomena of fermentation, by A. Certes and D. Cochin.—On the presence of duodenal anchylostoma in some Belgian hospitals, by Ch. Fisket.—On the presence of a coxal gland in *Galeodes araneoides*, by J. MacLeod.—Note on G. Edon's work on the Carmen Arvale, by Alph. Le Roy.—Some details on Wissant and its identification with the Portus Iccius of the Romans, by Alph. Wauter.—On the apparent enlargement of the orbs of the sun and moon, by Paul Stroobant.—On a new *Balenoptera rostrata* in the Mediterranean, by J. Van Beneden.—Discourse on geological chronology, by Ed. Dupont. —On the chief cause of cyclones and tropical calms, by M. Folie.

Bulletin de l'Académie des Sciences de St. Pétersbourg, tome xxix. No. 4.—On the applications of the interpolation method proposed by M. W. Tchebychef, by O. Backlund (in German). The fine method of the Russian mathematician is shown to be easily represented in a simple scheme, appropriate to calculations, and the author applies it to three examples, one of which is the calculation of Hasselberg's spectral observations. He shows that, with regard to the easiness and simplicity of calculations, the Tchebychef method leaves nothing to desire, while its results are as reliable as those obtained by the much more tedious method of least squares. Two other examples, one for the declinations as taken from the Cape Catalogue, and compared with those measured at Pulkova, and another for interpolating Pulkova double-star observations, give the same satisfactory results. As known, Tchebychef's method permits also to proceed without making any previous hypothesis as to the degree of the interpolation formula. On the whole, when a considerable number of data is given, and the least squares' method becomes especially tedious, Tchebycheff's method gives excellent results.—The elements and the ephemerides of the Encke comet for its appearance in 1884–85, by O. Backlund. The ephemerides are given from November 7, 1884, to May 6, 1885.—Demonstration of several theorems relative to the numerical function $E(x)$, by V. Bouniakovsky (in French).—Contributions to the Ornis of the Ternate Island, by Th. Pleske (in German). The birds brought from the above island by Dr. Fischer are determined with the help of Salvadori's "Ornithologia della Papuasia," &c. There are eighty-five species described. —Remarks on the *Elapomorphus* genus of Calamaride serpents, by A. Strauch (in German) Having received an herpetologic collection from Brazil, from Dr. Ihering, Prof. Strauch found in it a new species of *Elapomorphus*, which he describes under the name of *E. Iheringii*, and he accompanies the description by a thorough critical revision of all known species of the same genus. The paper is thus a systematic monograph of the genus, which contains now eighteen species.

THE *Belgique horticole* for July to September, 1884, contains a retranslation of Prof. Jacobsthal's essay on "The Evolution of Vegetable Forms in Decorative Art," and M. Guirand's on the gardens of the Mediterranean coast, which have already appeared in our columns. We have also other articles of interest taken from other journals, and the usual descriptions and admirable coloured plates of new plants.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, February 12.—"Note on the Condensation of Gases at the Surface of Glass." (Preliminary.) By J. T. Bottomley, M.A., F.R.S.E. Communicated by Prof. Sir William Thomson, F.R.S.

It is well known to those who have endeavoured to obtain, in glass vessels, the very perfect vacuums first sought after and obtained by Crookes, and producible by the mercurial pumps, that the operation is much assisted by heating the glass vessels to be exhausted, and even the tubes of the pump, to a high temperature. The difficulty of removing the film of air and moisture adhering to glass tubes is also well known to makers of barometers and thermometers.

When the Sprengel pump is used for producing a vacuum, and when a tolerably good vacuum has been produced, so that the barometric gauge indicates a presence of one millimetre or half a millimetre of mercury, the drops of mercury falling in the tube of the Sprengel give rise to a loud metallic hammering sound; and they fall with such unbroken sharpness that those who use this form of pump are often troubled by the "fall-tubes" splitting longitudinally through a length of several inches —a phenomenon in itself very remarkable, considering the strength of the tubes and the smallness of the mercurial drops. If, while this hammering is going on, the glass vessel which is being exhausted and the leading tubes of the Sprengel pump be heated by passing the flame of a spirit-lamp or of a Bunsen burner over them, the hammering immediately ceases, and on looking closely at the fall-tubes it is seen that they are carrying down air which the heat has liberated from the glass walls of the apparatus. The ordinary barometer-gauge is scarcely sensitive enough to show an increase of pressure, but the McLeod gauge readily shows it.

There is another well-known phenomenon connected with the condensation of gases and vapours on the surface of glass: viz. the condensation of a watery film over the glass of electric apparatus, in virtue of which, at temperatures considerably above the dew point, the glass supports are not insulators of electricity. This film of moisture is removed by exposing the glass stems to heat, or to an artificially dried atmosphere. Some years ago, at the wish of Sir William Thomson, I endeavoured to weigh this film of moisture, but was absolutely unsuccessful. The film must be of extreme tenuity. Prof. Quincke has, however, made important researches on the "distance of capillary action" and on some of the properties of these very thin films. His results are given in two papers: *Poggendorff's Annalen*, 108, p. 326, 1859; and *Wiedemann's Annalen*, vol. ii. 1877, p. 145. He finds their thickness to be comparable with 5×10^{-5} cm.

With the view of measuring the quantity of gas condensed upon a given surface of glass, I caused to be prepared in August last a large quantity of fine glass thread. Some of this was of flint glass rod or cane, which was softened in the blowpipe flame, and drawn out on to a wheel. The remainder was of flint glass tubes, drawn out in a similar way. The spun glass was carefully parcelled up in paper and put aside till I should be ready to use it.

On January 3 I put a quantity of the non-tubular glass fibre into a glass tube 2 cm. in diameter and 12 cm. long, and attached it by a glass sealing to a five-fall Gimingham Sprengel pump. The pump, which was in excellent order, was then worked rapidly till I had produced a very good vacuum, which by the McLeod gauge gave me an indication of 0·3 M pressure.[1] The pump was then left for about an hour, and at the end of that time, passing one more bottle full of mercury through the pump, I ascertained that the vacuum had not sensibly deteriorated, the McLeod gauge giving identically the same reading as before. This exhaustion was performed without the application of any unusual heat to the tube containing the glass fibres. The temperature of the room was about 56° F.

I now raised the mercury to the upper level and allowed it to flow through the pump, and the drops fell with the well-known loud hammering noise. While this was going on I applied a Bunsen burner to the tube containing the spun glass. In a few seconds the hammering of the mercury ceased, and on applying the test of the McLeod gauge the pressure within the pump was found to have risen largely. I did not, however, obtain a measurement with the gauge corresponding to the maximum pressure of the gas driven off, or to any particular state.

I now proceeded to pump out all the gas I could, working the pump and heating the tube containing the glass fibres strongly. The heating was carried on from time to time till the tube, which was of German glass, showed signs of softening and of falling in; and the glass fibres were likewise, some of them, slightly softened and bent.

The pump was worked for over an hour, the heating being applied, and the gas, which was easily seen being carried down, was collected in a tube made for the purpose, which was fitted on over the upturned ends of the five fall-tubes. At the end of this time the vacuum was again fairly good, though not so good as it was before the heating commenced. The McLeod gauge indicated 1·2 M. It was seen that very little more air was being carried down, and I did not wish to push the vacuum farther than, or quite so far as, the vacuum which had been obtained before the liberation by heat of the condensed gas.

The collecting tube was now removed, and the gas obtained was measured and analysed, so far as it was possible to analyse a quantity so small.

The total amount of gas collected was calculated to be, at 15° C. and a pressure of 760 mm., 0·45 of a cubic centimetre. To this a small quantity of strong solution of caustic potash was added, and time was given for absorption. A small quantity of pyrogallic acid was next added, and the further absorption observed. The residue was so small that I could do nothing farther.

1 M standing for one-millionth of an atmo.

The result of the analysis showed 8·24 per cent. of the whole to be carbonic acid gas (absorbable by caustic potash). Of what remained 24·8 per cent. was oxygen (absorbable by pyrogallic acid and caustic potash mixed). The residue, 75·2 per cent., was, I presume, mainly, if not wholly, nitrogen. I ought to remark that my pump was furnished, as is usual, with the phosphoric acid drying tube. The gas, therefore, which I collected was perfectly dry, and I have no way at present of ascertaining how much moisture adheres to the spun glass. In stating the results of the analysis I have made no correction for moisture introduced with the potash solution.

In order to make an estimate of the amount of surface exposed by the spun glass, I measured, with a screw micrometer gauge, the diameters of 200 of the fine glass fibres taken at random. I found them, as I expected from the care with which they had been prepared, fairly uniform, and the average diameter was 7·06 hundredths of a millimetre. Weighing also the 200, and then the whole quantity, I found the whole number of the fibres to be 6370. The average length was 10·25 cm. The surface was thus 1448 sq. cm., or equal to that of a square 38 cm. in the edge.

I am preparing for further experiments on this subject, and hope soon to be able to add to it observations on the amount and on the electric conductivity of the film of moisture condensed upon the surface of glass.

Additional Note.—Since the writing of my former communication on this subject, I have made some further experiments on it, and I beg leave to give an account of the results of one of these experiments.

Having filled a fresh tube with fresh spun glass, I carefully exhausted with the Sprengel pump on January 24, and the exhaustion was kept up till February 5—that is, for twelve days. During this time I frequently tested with the McLeod gauge. A very slight increase of pressure was found during that interval, but it was so slight that I am not able to say that it was greater than that which is observed at all times, even with the Sprengel pump in excellent order, when a vacuum is maintained for several days.

On February 5 I passed three or four bottlesful of mercury through the pump, and had a vacuum of about 0·5 M, as shown by the McLeod gauge. I then applied heat, and had instantly an abundance of gas given off from the spun glass. This was collected as before, and analysed.

The number of glass fibres was 15,500, giving an estimated surface area of 3527 sq. centims. The amount of gas given off was 0·41 c.c., which is considerably less in proportion than in my first experiment.

Of this gas it was found that 78·6 per cent. was carbonic acid gas (absorbable by caustic potash). Of the remainder 10·5 per cent. was oxygen (absorbed by pyrogallic acid and potash), while 89·5 per cent. was left unabsorbed, and may be supposed to be mainly nitrogen.

The very large proportion of carbonic acid gas is remarkable, and it is difficult to account for, unless we may suppose that it was taken up by the glass in large quantity during the operations of drawing out the glass into fibres and inclosing it in the containing tube—operations during which there was, in these preliminary experiments, an abundant supply from the blowpipe flames.

Chemical Society, February 5.—Dr. W. H. Perkin, F.R.S., President, in the chair.—A lecture was delivered "On Chemical Changes in their relation to Micro-Organisms," by Professor Frankland, F.R.S., a plant being defined as an organism performing synthetical functions, or one in which these functions are greatly predominant; an animal, as an organism performing analytical functions, or one in which these functions greatly predominate. The micro-organisms were classed by the lecturer among animals. Their life essentially depends upon the taking asunder of more or less complex compounds, resolving them into simpler compounds at the expense of potential energy. As micro-organisms are commonly termed "ferments," and their analytical operations "fermentations," it is necessary to sharply distinguish between organised ferments and certain bodies which bring about analogous chemical changes, but which are not only not organised, but exist in solution. These latter, or "soluble ferments," as they are commonly termed, are said to act by contact: they produce certain chemical changes in the fermentescible substances without themselves furnishing from their own substance any of the products of change; the effects they produce are essentially analytical, consisting in the assimilation of water and the splitting up of the fermentescible substance into two or more new molecules, and may be brought about by purely chemical means. They differ only, or chiefly, from the organised ferments in that they are unorganised and do not increase in amount during their action upon fermentescible substances, of which a very large, although limited, quantity may undergo transformation by the action of a very minute quantity of the ferment. A list of changes brought about by unorganised ferments was given. In that portion of the animal kingdom with which we are best acquainted, oxidation is the essential condition of life: it is the kind of action by which the animal changes actual into potential energy. The changes effected by micro-organisms are essentially of the same character as those brought about by the higher orders of animals: that is to say, they are all changes by which potential becomes actual energy. With one or two exceptions, the chemical changes effected by micro-organisms—unlike those produced by soluble ferments—cannot be brought about by other means. The observations of Hatton and others have shown that micro-organisms retain their vitality in presence of a variety of substances which rapidly prove fatal to higher animals; the unexpected fatal effects of pongy iron would seem to promise, however, that there are substances fatal to bacterial life which have no toxic effect on more highly organised animals. It has not yet been shown that any degree of cold, however intense, is fatal; animation may be suspended, but it is restored when the temperature rises. With regard to heat, the lowest fatal temperature recorded is 40° C., but many species can withstand much higher temperatures. Chloroform and compressed air are said to arrest their action, but have no influence in preventing the changes brought about by unorganised ferments. The position of micro-organisms in nature is only just beginning to be appreciated; their study both from chemical and biological points of view is, however, of the highest importance to the welfare of mankind, and leads the inquirer right into those functions of life which are still shrouded in obscurity. In the course of the lecture the best known micro-organisms and the chemical reactions due to them were passed in brief review. Prof. Frankland also referred to the following results of an experiment made in the month of June, in which fresh urine was allowed to stand for 25 days in a clean glass vessel:—

	Residue left on evaporation and drying at 100° C.	Organic carbon.	Nitrogen as urea and other organic matter.	Ammonia.	Microscopical observations.
Fresh urine	4817·0	943·81	1080·27	142·40	No bacilli.
,, after 1 day	—	940·46	1095·05	136·65	,,
,, ,, 3 days	—	928·76	1106·70	136·50	,,
,, ,, 5 ,,	—	882·66	983·26	288·55	Sparse bacilli.
,, ,, 7 ,,	—	739·82	900·80	338·60	
,, ,, 9 ,,	—	682·99	784·93	485·12	Numerous bacilli.
,, ,, 11 ,,	—	621·02	744·64	534·80	Very numerous bacilli.
,, ,, 14 ,,	—	559·22	481·49	870·62	Vast numbers of bacilli.
,, ,, 16 ,,	—	530·68	492·04	881·87	Mostly still.
,, ,, 18 ,,	—	487·01	355·25	990·78	,, ,,
,, ,, 21 ,,	—	466·43	278·22	1105·75	All dead or still.
,, ,, 23 ,,	—	451·43	347·45	1017·25	,, ,,
,, ,, 25 ,,	2718·0	460·78	283·90	1070·50	
After allowing for evaporation	2045·5	346·77	213·66	805·63	

The results of these observations and determinations which

were made during the month of June show conclusively that, previously to the development of *Bacillus ureæ*, the chemical composition of the urine remained practically unchanged; but with the appearance of micro-organisms, a diminution of organic carbon and a transference of nitrogen from the organic to the ammonia column immediately began. As regards rapidity, this change marched *pari passu* with the density of population, and reached its maximum about the 12th day; for during the three days (11th to 14th) nearly 10 per cent. of carbon disappeared, whilst more than 85 per cent. of the organic nitrogen became ammonia. After the 14th day the rate of change became much slower, on the 18th day the bacilli were mostly either dead or motionless, whilst on and after the 23rd day no more moving bacilli was seen. Altogether the quantity of carbon converted into carbonic anhydride, after allowing for concentration of the liquid by evaporation, amounted to 597·04 parts per 100,000 of liquid, or 63·3 per cent. of the total quantity; whilst the quantity of organic nitrogen converted into ammonia was 546·19 parts per 100,000, or 50·6 per cent. of the whole. These proportions show that all the organic nitrogen contained in the urea was not converted into ammonia. It no doubt escaped as free nitrogen, in accordance with Frank Hatton's observation. In the original urine the proportion of organic carbon to organic nitrogen was as 1 : 1·15, whilst, after the action of the bacilli, it was 1 : 0·62. Prof. Burdon Sanderson said that the main difficulty met with in studying the effects of micro-organisms arose from the fact that it was always difficult and often impossible to distinguish between different organisms. Chemists might naturally turn to biologists for aid in the matter, but biologists must admit the existence of this difficulty. We are fully acquainted with the life history of only one pathogenic organism—*Anthrax bacillus*; of this, thanks to Koch, we know, however, a great deal. The method followed by biologists in studying pathogenic forms was, in the first instance, to prepare a pure cultivation of the organism, and then to obtain the proof that the organism produces its proper effect when transferred to a living animal. The morphological relations of bacteria with plants could not be questioned, but he thought it was really of little consequence for practical purposes whether ferment organisms were regarded as animals or plants; what we want to know is, what are the conditions under which an organism is produced, and its life history. He was in the habit of calling them microphytes, as being a neutral term.—Prof. Ray Lankester was astonished at the definite way in which Prof. Frankland had classed the ferment organisms with animals. Naturalists were led to regard them as plants from examining their relations to other organisms. He agreed with Prof. Sanderson that "microphyte" was a good name for them, although not precisely for the same reason, but because it really meant a little plant. He stated that it was held hitherto that a micrococcus induced the ammonic change in urine, and not a bacillus as figured by the lecturer. For the purpose of chemical investigation, it was essential to have a pure cultivation. It was curious that the nitrifying organism had not been isolated; its presence had only been inferred, and it had never been satisfactorily separated and identified, although inconclusive statements and observations purporting to inform us as to the form of that organism had been published.—Dr. Brunton said that it was highly probable that the symptoms occurring in certain diseases were due to poisons formed by the action of organisms and not directly to the organisms themselves. This was not improbably the case in cholera. Micro-organisms may even produce substances fatal to themselves, *e.g.*, phenyl compounds. This is also the case with higher organisms, the retention of the urine in man being often attended with fatal results. Although cholera was very probably due to the presence of low organisms, the symptoms were so very like those produced by certain poisons, that it was very difficult to diagnose cases of poisoning by arsenic from cholera cases. The cholera poison was probably of an alkaloïdal character and related to the ptomaines. Pepsin converted albuminoids into peptones, but it was important to note that Brieger had observed that sometimes an alkaloid having an action similar to curare was formed during peptic digestion, and an alkaloïd having a similar action had been obtained from human urine. These facts rendered it probable that alkaloïds might be formed in the intestinal canal and absorbed into the general circulation. Prof. M. Foster said that the question whether the micro-organisms in question were plants or animals was to him a matter of indifference compared to the question—what was the exact nature of the action by which the organism effected the chemical change? He desired to point out that in certain cases, as in the ammonic conversion of urea, the same change, in this case the conversion of urea into ammonium carbonate, was effected, on the one hand, by a micro-organism, a micrococcus or bacillus, and on the other hand by an unorganised ferment. His friend Mr. Sheridan Lea informed him that he had evidence of both these causes of ammonic conversion of urea. Now, was the action in both cases the same? The idea had naturally occurred that the organism produced its effect by producing an organised ferment. But all attempts to prove the production of such a secretion, so to speak, of a ferment had failed If such a ferment were produced, it was destroyed or disappeared during its action, whereas ordinary unorganised ferments such as pepsin, &c., were not destroyed at all during their activity, or were destroyed very slowly. On the whole, the probability was that the micro-organism and the unorganised ferment produced the same result in different ways; ought not the *difference* to offer the key for solving the problem? He further desired to remind the Fellows that actions similar to those of these micro-organisms were continually being carried on by the constituent elements of man and other macro-organisms, and would wish, in illustration, to call their attention to the act of secretion by a secreting cell, such as the pancreatic cell. We had evidence that certain constituents of pancreatic juice existed in the cell, not in the form in which they appear in the juice itself, but in an anterior, more complex condition. Thus trypsin occurs in the pancreatic cell not as trypsin but as trypsinogen. Now this trypsinogen, and also probably other "mothers" of the constituent of the juice, exist in the protoplasm of the cell as *discrete granules, lodged in the meshes of the protoplasm, separated from the protoplasm by films of fluid.* Yet the protoplasm, stirred by some nervous impulse, is able to produce a change in these granules, so that they are discharged to form the secretion. How does the protoplasm work upon these granules? Does it discharge something into the fluid of its meshes, which something acts upon the granules? or does it work upon the granule through the film of fluid surrounding the granule, by something which is a sort of "action at a distance"? The action, then, in this case is very comparable to the action of the micro-organisms in question. It is for the chemists to throw light on the exact nature of the changes produced, and, when this is done, we may hope to learn how the change is brought about; but not until this is done.—Mr. Thistelton Dyer said that from the botanist's point of view he was struck with the universality of fermentative changes. Though they were so predominant a feature in the life of the lower plants, this was only an extreme manifestation of what, perhaps, all plants were capable of, if the conditions demanded it. Thus Pasteur, following up an experiment of Bérard's, found that a rhubarb leaf in an atmosphere of carbon dioxide yielded, after 48 hours, though apparently unchanged, small quantities of alcohol. The breaking up of molecules of large thermic equivalent into those of less, supplies the energy needed for the continued life of the tissues, and is the *raison d'être* of the process. But plants also set up fermentative changes external to themselves, as it were incidentally and without any obvious benefit. The investigation of Beyerinck on the production of gum by plants yielded most remarkable results. It is due to a disease which is highly contagious, and which is caused by a fungus (*Coryneum*). This produces a ferment which changes the cell-walls into gum. But what is most remarkable is that even after the disappearance of the fungus which initiated the changes, the the cells of the host plant take on a morbid habit of growth, and themselves continue the production of the ferment and therefore of gum to their own hurt. The problem is here of the most complicated kind. The series is ended by cases such as that of *Withania coagulans* (and many others are now known), where plants throw off, as bye-products of their metabolism, ferments as effective as rennet, without deriving any perceptible advantage from their possession. That plants use in working up their reserve-proteid proteolytic ferments just as animals do, cannot be doubted. But even these they occasionally, as in the Papaw, produce in utter disproportion to their own possible requirements. Mr. Warrington said with regard to the difference between animals and plants, he thought the fact had been somewhat overlooked that plants are able to obtain their nitrogen from such simple compounds as ammonia and nitrates, whereas animals appear to require to have the nitrogen presented to them in an albumenoid form. As to the nature of the nitrifying organism, Müntz and Schlösing claim to have isolated it and have described it. A friend who

had microscopically examined his purest cultivations at Rothamsted, had been unable to find bacilli, but they appeared to contain a micrococcus. [Prof. Lankester, interposing, remarked that the growth sent to him by Mr. Warrington consisted of bacilli, and nothing else.] In explanation, Mr. Warrington said that in one of his earlier papers he had mentioned that white films appeared on some of his solutions. Prof. Lankester had examined these, but he had since found that the bacilli of which they consisted were incapable of nitrifying ammonia. Latterly he had followed Dr. Klein's method, and had introduced the infecting matter into the sterilised cultivation liquid by means of a capillary pipette, which was pushed through the cotton-wool plug closing the tube or flask; since he had done this, the films referred to had never been formed. Dr. Thudichum agreed that the ammonic changed was produced in urea by a micrococcus. The study of microphytes and of the chemical changes produced by them in the human body and in the bodies of animals was of the greatest importance. He questioned whether their action was always so specific, however, as was commonly supposed. He would also call attention to the fact that one micro-organism will kill another: thus, after plastering wine, in consequence of the removal of the tartrate, the microphyte which produces ropiness is crowded out by alcoholic forms. Dr. Stevenson calleda ttention to the importance of obtaining more imformation as to the alkaloidal bodies formed by the action of micro-organisms. Prof. Frankland replied that he did not mean absolutely to say that in his experiments the work was done by the *Bacillus ureæ*, but the diagram was a faithful representation of what he saw; he attributed the action to the particular organism, because it commenced when the organism appeared, and ceased when the bacilli became motionless. The necessity of studying the actions of pathogenic organisms had been prominently brought forward in the discussion. He thoght there was a substantial difference between the class of chemical changes effected by plants on the one hand and by animals on the other; animals more particularly consumed as food those compounds in which much energy was stored up.

Geological Society, February 11.—Prof. T. G. Bonney, F.R.S., President, in the chair.—Arthur William Clayden, Samuel Rideal, and H. W. Williams were elected Fellows of the Society.—The following communications were read:—The Tertiary and older peridotites of Scotland, by John W. Judd, F.R.S., Sec.G.S. The very interesting rocks known as "peridotites" have been regarded by many petrographers as peculiar to, and, indeed, characteristic of, the older geological periods; but in the Western Isles of Scotland there occur a number of rocks of this class, constituting portions of intrusive masses, which the author, in a previous paper, has shown to be the central cores of Tertiary volcanoes of vast dimensions. These Tertiary peridotites are most intimately associated with the gabbros and dolerites, the felspathic and non-felspathic rocks passing into one another by insensible gradations, and the rocks of either class being intersected by veins of the other. The peridotites exhibit the same varieties of microscopic structure as the associated gabbros and dolerites, these structures being described under the names of "granitic," "ophitic," and "porphyro-granulitic." The felspars, which are rare in the peridotites, are intermediate in composition between labradorite and anorthite; they rarely, however, exhibit evidence under the microscope of being built up of laminæ belonging to different species. The study of the lamellar twinning, which is a common, but by no means universal, character in these felspar crystals, points to the conclusion that it has been induced by pressure or strain, like the similar structure in rock-forming calcite. The pyroxenes are represented by many varieties, both of the monoclinic forms (augites) and the rhombic forms (enstatites), the former being by far the most abundant. The olivines below are, for the most part, highly ferruginous varieties. The spinellids, magnetite, chromite, and picotite occur in these rocks, as do also titano-ferrite and its alteration-products. Among the accessory constituents biotite is the most abundant. It was shown that each of the minerals of these rocks is found to undergo remarkable changes as we pass from the superficial to the central portions of these intrusive rock-masses. The most important of these changes is that for which the author proposed the name "schillerization." It consists in the development of microscopic inclosures, in the form of plates and rods, along certain planes within the crystal, giving rise to metallic reflections or a play of colour. The felspars, pyroxenes, and olivines are all found to be affected in this way when they have formed the deepest parts of these volcanic cones. In this way common augite is seen at gradually increasing depths, passing into the deep-brown variety known as pseudo-hypersthene. The last-mentioned substance presents a curious mimicry of true hypersthene and paulite, which is the schillerized form of a ferriferous enstatite. The Tertiary peridotites present many variations, not only in their structure, but also in their mineralogical constitution. Among them occur examples of the rocks which have received the names of dunite, picrite, and lherzolite, with some curious types composed of felspar and olivine. Among the older peridotites of Scotland a new and very interesting type is described from near Loch Scye in Caithness. It appears to have been originally a mica-picrite, but the whole of the original minerals have been converted into paramorphs, firstly by schillerization, and subsequently by amphibolization and serpentinization. In conclusion, it was pointed out that the discrimination between the effects of the changes described as schillerization, and those known as uralitization, amphibolisation, serpentinization, and kaolinization is of the utmost importance, not only to the petrographer, but to the mineralogist.—Boulders wedged in the Falls of the Cynfael, Ffestiniog, by T. Mellard Reade, F.G.S.

Royal Microscopical Society, February 11.—Anniversary Meeting.—The President (Rev. Dr. Dallinger, F.R.S.) in the chair.—The Report of the Council showed a remarkable development of the Society during the last six years, 301 new Fellows being elected as against 97 in the preceding six years. The income showed also an important increase.—Dr. Carpenter, in moving the adoption of the Report, referred also to the success which had attended the Society's *Journal*.—Dr. Dallinger then gave his annual address to what was probably the largest gathering of Fellows ever assembled on a similar occasion. After briefly referring to the increased interest lately manifested in the study of minute organisms and recalling the characteristics of the doctrines of abiogenesis and biogenesis, he passed rapidly in review the results of the observations of Tyndall, Huxley, and Pasteur as bearing upon these questions, and called attention to the observations of Buchner as to the transformation of *Bacillus anthracis* and *Bacillus subtilis*, and *vice versâ*, and referred with approval to Dr. Klein's criticisms thereon. Having spoken of the desirability of careful and continuous study of this class of organisms, and the importance of endeavouring to establish the relation of the pathogenic form to the whole group, he said he should be better able to deal with the subject by recording a few ascertained facts rather than by making a more extended review, and he therefore devoted the main part of his address to a description of "the life-history of a septic organism hitherto unknown to science." In his observations of this form—extending over four years—he had the advantage of the highest quality of homogeneous lenses obtainable, ranging from one-tenth to one-fiftieth of an inch, his chief reliance being placed upon a very perfect one-thirty-fifth of an inch; and from the continuous nature of the observations, as well as the circumstances under which they were carried on, dry lenses had for the most part to be employed. Having in his possession a maceration of cod-fish in a fluid obtained from boiled rabbits, he found at the bottom of it, when in an almost exhausted condition, a precipitate forming a slightly viscid mass, to which his attention was particularly directed. It was seen to contain a vast number of *Bacterium termo*, but on examination with a one-tenth inch objective showed that it also contained a comparatively small number of intensely active organisms—one being discovered in about eight or ten drops of the sediment. These measured 1-10,000th of an inch in length by 1-19,500th of an inch in breadth. The fluid had originally been kept at a temperature of 90° to 95° F., and it was noticed that, when placed upon a cold stage under the microscope, the movements of the organisms became gradually slower, until at last they entirely ceased; the necessity, therefore, arose for the use of a warm stage, and the very ingenious contrivance, by which a continuous and even temperature was maintained within the one-tenth of a degree, was exhibited. The greatest difficulty in the matter was, however, experienced in obtaining specimens for observation, in order to be able to trace them from their earliest to their latest stage.—The President then explained, by means of an admirable series of illustrations projected upon a screen by the oxyhydrogen lantern, the life-history of the organism to which he had referred, exhibiting it first as a translucent, elliptic, spindle-shaped body, with six long and delicate flagella, the various

positions in which the five specimens were drawn giving a very good idea of its peculiar porpoise-like movements. The various positions which it assumed in making an attack upon a portion of decomposed matter were also shown, the movements quite fascinating the observer by their rhythmical character. The supposed action of the flagella in the production of the movements observed was explained, distinct evidence being afforded of a remarkable spiral motion, at least of those behind. The process of fission was illustrated in all its observed stages from the first appearance of a constriction to that of final and complete separation, the whole being performed within the space of eight or nine minutes. A description of the process of fusion from the simple contact of two organisms to their entire absorption into each other followed, as well as their transformation into a granular mass which gradually decreased in size in consequence of the dropping of a train of granules in its wake as it moved across the field. The development of these granules was traced from their minute semi-opaque and spherical form to that of the perfect flagellate organism first shown, the entire process being completed in about an hour. Experiments as to their thermal death-point showed that, whilst the adults could not be killed by a temperature less than 146° F., the highest point endured by the germs was 190° F. Illustrations of a variety of other modes of fission discovered in previous researches on similar forms were given, showing the mode of multiple division and a similar process in the case of an organism contained in an investing envelope. The President concluded his address, which was listened to throughout with the greatest attention, by remarking that, though the processes could be seen and their progress traced, the *modus operandi* was not traceable. Yet the observer could not fail to be impressed with the perfect concurrent adaptation of these organisms to the circumstances of their being; they were subject to no caprices, their life-cycles were as perfect as those of a crustacean or a bird, and, whilst the action of the various processes was certain, their rapidity of increase and the shortness of their life-history were such that they afforded a splendid opportunity of testing the correctne s of the Darwinian law.—Dr. Carpenter complimented the President on the value and interest of his address, and moved a vote of thanks, which was seconded by Mr. Crisp, who referred to the sacrifices the President had had to make in the performance of his duties during the past year. The new Council were elected.

Anthropological Institute, February 24.—Francis Galton, F.R.S., President, in the chair.—A paper on the race-types of the Jews, by Dr. A. Neubauer, was read. The opinion that the Jewish race have kept their blood unmixed is based chiefly on the fact that a Jew is almost at once recognised amongst thousands of others. From the earliest times, however, we find evidence of intermixture. Abraham's son, Ishmael, was the offspring of an Arabian woman; Joseph married an Egyptian, and Moses a Midianite. David descends from Ruth, the Moabitess, Solomon is the son of a Hittite woman, and he himself had foreign wives. We are often reminded in the Bible of the non-Jewish women who came in contact with the Israelites, and undoubtedly the "proselytes" increased the mixture of races by marrying Jewish women. At Rome the conversions were numerous, and, of course, the converts frequently married Jews. Evidence was also adduced of intermarriages in later times between Jews and Christians of various races. The differences between the Spanish-Portuguese Jews and the German-Polish Jews were so marked that in the middle ages they were believed by the Jews themselves to have descended from different tribes—Judah and Benjamin respectively. But the Italian Jews, both in features and habits, stand between the rough German and the polished Spanish Jews, and there is no evidence of any systematic emigration of the various tribes. The pronunciation of Hebrew words also varies, and this variation is believed by Dr. Neubauer to be due to the influence of the language spoken by the surrounding peoples. The difficulties of obtaining accurate measurements of Jews are very great, and but few skulls have been examined; all evidence, however, goes to disprove the existence of any pure Jewish type, uninfluenced by contact with the nations amongst which they dwell.—Mr. Joseph Jacobs read a paper on the racial characteristics of modern Jews. After enumerating the various classes of Jews now existing, the inquiry was limited to the biostatics and anthropometry of the Ashkenasim Jews, who form more than nine-tenths of the whole number. Their superior fecundity and vitality were found to be due to social causes, and were therefore only secondarily racial; an indication of racial influences was found, however, in the fact that mixed marriages between Jews and Christians are infertile. Jews enjoy no immunity from any special diseases, but they are more often colour-blind, blind, deaf, and insane than others, owing, perhaps, to their life in cities and to their frequent intermarriages. Jews were then shown to be the shortest of all Europeans except the Magyars, and to have the narrowest chest. Their skulls are mostly brachycephalic. An examination of over 100,000 Jews showed that they have darker hair and eyes than those of any nation in Northern Europe, though nearly one-fifth of the Jews have blue eyes, and they have nearly twice as many red-haired individuals as the inhabitants of the Continent. A number of composite photographs of Jewish boys, prepared by Mr. Galton, were exhibited to show the Jewish type, and were compared with early representations of Jews in Assyrian art. The Jewish face was said to be a combination of Semitic features and Ghetto expression. Turning to the question of the purity of the race, it was pointed out that this depended on the number of proselytes made by Jews in ancient and mediæval times. The earlier proselytes, before the foundation of Christianity, were mostly fellow-Semites, and would not affect the type, while the numbers made afterwards were too small to modify the race, owing to their infertility and the tendency of the offspring to revert to the Jewish parent. A considerable number of Jews, the Cohens, or descendants of Aaron, were not allowed to marry proselytes, and must consequently be tolerably pure. The general conclusion reached was therefore in favour of the purity of the Jewish race.

Royal Meteorological Society, February 18.—Mr. R. H. Scott, F.R.S., President, in the chair.—Messrs. H. B. Baker, M.D., S. Dixon, R. Foster, and B. O. Meek, F.L.S., were elected Fellows of the Society.—The following papers were read:—How to detect the anomalies in the annual range of temperature, by Dr. Buys Ballot. The author shows that it is most likely that only a long-continued series of observations can give some evidence of an interruption of rise and fall, especially in latitudes where the temperature of the same day in different years may differ by 20° C., as in St. Petersburg.—Cloud observing, by D. W. Barker. As there is a great deal of confusion amongst cloud-observers, not only as to the particular names of clouds, but more especially with regard to their movements, the author recommends that there should be two simple divisions, viz. "stratiform" and "cumuliform." To the stratiform belong all the higher forms of cloud and a few of the lower; to the latter belong the typical cumulus cloud always seen in the lower atmosphere. From the result of numerous observations the author's conclusion is that the actual normal action of the cirro-filum cloud is along the line of filature, and that, knowing the bearing of the V or radiating point, the direction of its motion can be at once inferred. In all cases the V point first formed in the point from which the cloud is coming, but it will frequently be noticed that threads first appear parallel to a certain point on the horizon, and in all sorts of positions between this and the central V point.—A suggestion for the improvement of radiation-thermometers, by W. F. Stanley. The author suggests that the radiation-thermometer should indicate the amount of heat radiated by the sun upon a metal ball of a certain size, this being an object easy of uniform reproduction by mechanical means. For experiment he made three hollow copper balls, which were cast with ordinary filed cores, and were of different weights. These balls were turned to exact external diameter of 1·4 inch, with similar necks of the insertion of thermometers. The surfaces were oxidised by heating to resemble the oxidation produced by the atmosphere. In each of these balls a similar thermometer was inserted, closing around the neck just sufficient to keep it steady by cotton thread soaked in paraffin. The three thermometers thus inclosed in the metal balls, when exposed to sunshine and placed at two inches above a piece of black board, appeared to register, under similar conditions, exactly alike. The experiments for three summer months gave from 6° to 11° difference between the sun and shade.

Entomological Society, February 4.—R. McLachlan, F.R.S., President, in the chair.—The President returned thanks for his election, and nominated Messrs. Dunning, Stevens, and Weir as Vice-Presidents for the coming year.—Two new members were elected.—Mr. J. W. Slater exhibited a specimen of *Polyommatus chryseis* from Aberdeenshire.—Rev. A. Fuller exhibited a collection of insects captured along the line of the Canadian Pacific Railway.—Mr. W. Cole exhibited a wasp's nest which appeared to have

been inhabited by *Vespa norvegica* and *sylvestris* in common.—Mr. W. L. Distant exhibited a series of wings of Indian butterflies, received from Mr. de Nicéville, showing the differences between broods of the same insect in the wet and dry seasons respectively, which had hitherto been generally regarded as distinct species.—Mr. E. A. Butler exhibited egg-cases of three species of *Mantidæ* from Bechuanaland.—Mr. W. F. Kirby (on behalf of Herr Buchecker, of Munich, who was present as a visitor) exhibited three volumes of drawings of *Hymenoptera.*—Mr. H. T. Stainton exhibited specimens of *Chauliodus insecurellus* from Gascony.—Mr. T. R. Billups exhibited various English *Ichneumonidæ* and *Hemiptera.*—Papers read:—Mr. G. F. Mathew, on the life-history of *Papilia Schmeltzi*, *P. Godeffroyi*, and *Xois Sesara;* and Mr. G. Lewis, on a new genus of *Histeridæ* from Japan.

EDINBURGH

Royal Society, February 16.—Mr. John Murray, Vice-President, in the chair.—Mr. W. E. Hoyle read the first part of a paper on the Cephalopoda of the *Challenger* Expedition. Mr. Hoyle confined attention in this paper to the octopods. Nineteen of these are new to science.—Sir W. Thomson gave a communication on energy in vortex motion. This subject he treated under five heads:—(*a*) energy in vibrations; (*b*) unlimited augmentation of energy of a simply continuous fluid mass in a space of given shape, by changes from and back to this shape; (*c*) annulment of energy under same conditions; (*d*) reduction of energy to absolute minimum in a multiply continuous space of given shape; (*e*) unlimited augmentation of energy in a multiply continuous space.—Dr. Thomas Muir submitted the first part of an exhaustive investigation into the theory of determinants in the historical order of development.—Dr. Muir also, in a paper on bipartite functions, developed a new notation for the expression of quantics, and proceeded to exemplify its use by applying it to the simplification of the proof of Galois's theorem regarding the continued fraction representation of the roots of an equation.—A letter from Prof. Michie Smith was read. He observed the zodiacal light from the top of Dodabettah. No bright lines were seen, and the light did not appear to share in the diurnal motion of the heavens, for it was seen unaltered in position for four hours after sunset. Prof. Smith also showed that in a condensing mist the air-potential is uniformly and markedly higher than the average for the time of day, while the reverse occurs in an evaporating mist.—Prof. Tait gave experimental proof of Sir W. Thomson's theory of the equilibrium of vapour with a liquid under surface-tension by means of two atmometers, in one of which artificial condensation was produced, while under the atmospheric conditions at the time evaporation would be going on in both.—Mr. John Aitken exhibited a new apparatus for the combination of colours.

PARIS

Academy of Sciences, February 21.—M. Rolland in the chair.—Annual elecution, by M. Rolland, President of the Academy for 1884. The chief topics touched upon were the life and work of the late distinguished members of the Academy—M. J. B. Dumas, MM. du Moncel, Wurtz, and Thenard; the aërostatic essays of MM. Renard and Krebs, which were regarded as marking a new era in aërial navigation; M. Janssen's action in reference to the universal meridian adopted at the recent Congress of Washington; the outbreak of cholera in the south of France and in Paris; M. Pasteur's experiments with the charbon virus and rabies; the progress of electric discoveries.—Announcement of the prizes awarded for the year 1884. Amongst the successful competitors were MM. Manen and Hanusse (mechanics); M. Baills (traité de balistique rationelle); M. Riggenbach (mountain railway); M. Jules Houël (contributions to pure mathematics); M. du Rocher du Quengo (improvement in screw steam navigation); M. Radau (astronomy); M. Ginzel (lunar physics); M. G. Cabanellas (theory of applied electricity); M. Alfred Durand-Claye (statistics); M. Chancel (organic chemistry); M. Emile Rivière (geology); M. Otto Lindberg (botany); M. P. Fischer (zoology); M. Testut (medicine and surgery); Dr. Cadet de Gassicourt (diseases of infants); M. Tourneux (embryology); MM. Cadiat and Kowalevsky (anatomy); MM. Jolyet and Laffont (experimental physiology); Capt. H. Berthaut (physical geography); M. Marsant (improved safety lamp for miners); M. de Tastes (meteorology); Dr. Neis (geographical exploration); M. J. Boussingault (applied chemistry).—Programme of the prizes prepared for the years 1885, 1886, 1887, and 1893. Amongst these is the sum of 100,000 francs left by M. Bréant in 1849, and still unawarded, "to whoever shall find an efficacious remedy for Asiatic cholera, or shall discover the causes of this terrible scourge." To secure this valuable prize it will be neces ary (1) to find a means of curing Asiatic cholera in the immense majority of cases; (2) or to indicate with absolute certainty the causes of Asiatic cholera, so that by their suppression the epidemic shall cease; (3) or to discover a certain prophylactic as infallible, for instance, as is vaccination for small-pox.

STOCKHOLM

Royal Academy of Sciences, February 11.—The following memoirs were presented for insertion in the *Transactions* of the Academy.—Contributions to the knowledge of the Spongiæ of Bohuslan, by Herr C. Fristedt.—On a Silurian scorpion from Gotland, by Profs. Tamerlan Thorell and G. Lindström.—Review of the Salmonoids of the Stockholm Museum, by Prof. F. A. Smitt.—On the structure of the organs of circulation and digestion in the Annilides of the families of the Amphoretidæ, Terebellidæ, and Amphictenidæ, by Herr A. Wirén.—Prof. Edlund communicated the results of his latest researches on the nature of the electric discharges in air of unequal density.—Prof. Rubenson spoke in his paper on the passage of the light through isotropic substanees.—Prof. Nordenskjöld presented for the *Proceedings*—(1) Catalogue of the meteorites in the Mineralogical Museum of the University of Upsala, by Dr. G. Holm; (2) researches on varieties of Diopside from Nordmarken, by Herr G. Flink; (3) hydrographic and chemical observations during the Swedish expedition to Greenland in 1883, by Herr Axel Hamberg.—Prof. Warming reported on comparative researches on the anatomy of the stems and the subterranean stolons, by Herr Fritz Haupt.—The Secretary of the Academy, Prof. Lindhagen, presented: on the minerals of the didymium group, by Dr. M. Weibull. On mononitro-a-naftalacid, by Dr. A. G. Ekstrand. On the chlorophyllophyceæ of Siberia, by Dr. R. Boldt.

CONTENTS

THURSDAY, MARCH 12, 1885

THE SNAKE-DANCE OF THE MOQUIS OF ARIZONA

The Snake-Dance of the Moquis of Arizona; being a Narrative of a Journey from Santa Fé, New Mexico, to the Villages of the Moqui Indians of Arizona, &c. By John G. Bourke, Captain Third U.S. Cavalry. (London: Sampson Low and Co., 1884.)

THE Pueblo Indians of New Mexico and Arizona have this general name from living in towns (Spanish *pueblo*, from Latin *populus*). Near a river, or oftener on the top of a steep-cliffed *mesa* or table-rock, may be seen these picturesque communal settlements, with their close rows of flat-roofed dwellings, walled with stone and mud, rising in terrace above terrace reached by wooden outside ladders, the whole forming a fortification strong enough to resist a sudden attack of the Apaches or Navajos of the plains, whose ravages in old times led the ancestors of the present Moqui, Zuñi, and other Pueblo tribes to resort to their peculiar architecture. Though these peoples were brought more or less under Spanish rule from the sixteenth century, and had to conform more or less to the Roman Catholic Church, the general barrenness and inaccessibility of their region saved them from being Europeanised to the obliteration of the native culture, like the nations of Mexico proper. In the Pueblos the archaic system of society, framed on maternal descent and exogamy, is still in full vigour, while the complex native religion seems almost as perfectly preserved as if the missionaries had never made the Indians wear silver crosses to their necklaces and march in procession to church on Corpus Christi. Thus it has come to pass that now, when the country has become United States territory, and the traveller bound for San Francisco passes close under the mud-walls of Laguna, there is made accessible to anthropologists a remarkable phase of barbaric society among a mild and intelligent people, where its study can be followed into the minutest detail. A few years ago, Mr. Cushing's papers in the *Century Magazine*, describing his life in Zuñi, excited wide interest. Now we have another instalment of Pueblo literature from Capt. Bourke, the officer selected by Gen. Sheridan to examine the manners and customs of the Indians of the South-Western Territories, and who in August 1881 went with a party to see one of the great rites of the Moqui religion, never before witnessed by a white man.

On his way to the Moqui towns, Capt. Bourke paid a visit to the Pueblo of Santo Domingo. Here the Indians profess to be Catholics, but (as the cura of the parish last year admitted to the writer of the present notice) they keep their old religion too. This comes out in the description of the festival Capt. Bourke's party were present at, where the procession-dance was performed by men with bodies painted pink and white, and wearing only the cotton kilt of their forefathers, while the women's headdresses were thin wooden tablets of Zuñi make, cut in the step-pattern which in Pueblo art conventionally represents the rain-clouds, for the coming of which to fertilise their arid country the ceremonies of Pueblo religion are one unceasing prayer. The clowns had the same prominent position as in the Zuñi dances sketched by Cushing; naked all but the old Mexican *maxtli* around their loins, and painted all over in black and white stripes, with tortoise-shells rattling at their knees, and their hair tied in with corn-shucks, they pranced hither and thither among the dancers. The whole purpose of the dance has been so far changed that it has become a procession bearing offerings to the shrine of St. Dominic, but even here the clowns are allowed their old licence, and chaff the Saint himself quite familiarly. There seem to have been more secret rites which the visitors were not allowed to see; indeed, when Capt. Bourke and Mr. Moran attempted to descend, note-book in hand, by the ladder through the sky-hole into one of the *estufas*—that is, the large cellar-chambers which serve as temples and council-houses—they were seized and ignominiously "fired out" by the yelling crowd below. A few days later, however, when they reached the rocky *mesa* on which stand the three Moqui Pueblos of Suchongnewy, Hualpi, and Hano or Tegua, to visit which was the object of their journey, Capt. Bourke found his way so well prepared by Mr. Cushing, that he was allowed the utmost liberty in examining everything connected with the snake dance, the great event around which all social and religious life naturally centred at the time.

A few days before, the young men had been out to the north, west, south, and east to collect snakes, and in one of the *estufas* Capt. Bourke found the whole catch stowed away in three great earthenware *ollas*. Next day the reptiles were to be seen turned out in a writhing mass, while two very old men lying on the ground were "herding" them: whenever a snake tried to wriggle away, they sat up, and with their eagle-feather wands gently brushed it till it turned back to the heap. These snakes were of several kinds, but mostly rattlesnakes, and youths came down the ladder from time to time bringing others, up to five feet long, wriggling in their hands. When the time approached for the ceremony, the visitors were politely got away to sit on a terrace-roof, where they could command a view of the procession, close to the sacred rock in the *plaza* or square, near which was planted in the ground a cottonwood sapling, apparently as a symbolic sacred tree; between the two stood a miniature conical lodge covered with buffalo hide, imitating in shape the *tepi* of the Sioux, and strongly suggesting a past time when the ancestors of the Pueblos may have lived as roving hunters on the prairie. The house-tops were crowded with women and naked children waiting for the procession. A noise of whirring and rattling, and there came forth from the arcade an old man sprinkling water on the ground, another carrying a basket of the sacred meal, men and boys with rattles, and another old man bearing a ceremonial bow, and whirling around his head a flat slip of wood fastened to a cord, in which we may recognise the "bull-roarer" known alike to the sacred rites of Australians, Kafirs, and ancient Greeks. Then came a party of dancers with their bodies painted green-black and faces blackened down to the upper lip and pipe-clayed below, with kilts of painted cotton, coyote-skins

hanging behind, rattles clanking at their knees, and eagle-feather wands in their hands. There was chanting, stamping, and a circuit made around the sacred rock, with the pantomimic dance of planting corn; after which the women and girls, gay in blankets of scarlet and white, carried around their baskets and scattered corn-meal. The dancers' party filed off through the arcade, but soon returned marching two and two, the left-hand men carrying snakes, some in their hands, some in their mouths or actually between their teeth, while the right-hand men, toward whom the snakes' heads were kept turned, tickled them with the feather-wands. Slowly the dancers tramped round the *plaza*, raising their knees to waist-height, the snakes writhing and squirming to get free till their bearers dropped them on the ground at the east corner, and the squaws half-smothered them in showers of the sacred meal. They were picked up by men and boys and passed on to safe keeping in a receptacle lined with buffalo-skins in the sacred lodge. Again and again the dancers came round with more snakes held in their teeth, even two at a time by one daring performer, till all, above a hundred, had been carried round, when they were passed out again, placed within a circle of meal in front of the sacred rock, smothered in meal again, prayed over by the chief priest, then caught up in handfuls by the dancers, who rushed with them to the eastern crest of the precipice and down the break-neck trails to the foot, where they released the reptiles to the four quarters of the globe.

The question how this extraordinary performance is managed may be in part answered. The idea of its being a mere trick may be set aside, as the snakes have not their fangs drawn, and indeed it is mentioned that the youths, though they handle the creatures recklessly while stretched at length, call in the aid of the old men as soon as a rattlesnake begins to coil ready to strike. It may be suspected, however, that the snakes have been made to bite cloths or such things before the dance, so as to reduce their poison and make them less dangerous. It is plain that the wands with the eagle-feathers are highly effective in keeping the snakes back by fanning and tickling. We are not told exactly how they act, but the Moquis believe that the snakes dread their enemy, the eagle, whose mode of attack, they say, is to tap the serpent gently with one of his wings, and exasperate it into making a spring. When the snake has lunged out all its force and struck nothing but feathers, its strength is gone, and it lies uncoiled on the ground, where the eagle seizes it in his talons and flies off with it. There may be in this story a hint of the actual purpose of the feather-wand. Through want of knowledge of the Moqui dialects, Capt. Bourke's party did not get much information on the spot as to the origin and purpose of the snake-dance, but this want was in some measure supplied at Zuñi, where Nanahe, a Moqui by birth but a Zuñi by adoption, gave an explicit account in the Zuñi language, which Mr. Cushing translated. The care and preparation of the dance, Nanahe said, belong to a secret order first established in the Grand Cañon of the Rattlesnakes, and the Moqui ancestors migrating eastward brought it with them. At first all members of the order were of the Rattlesnake gens, but as time passed, that clan became numerous and mixed with the other clans. To keep the order from getting too big, no members were taken in unless belonging (that is, by descent through the mother) to the Rattlesnake gens, or unless when a member dies his son is taken in, as was Nanahe's own case; but a man would not come in merely by inheritance if he had not the proper qualities, and on the other hand a man of brave heart and good character would be likely to be admitted, although neither his mother nor his father was a Rattlesnake. "From the Moqui villages the order spread to other villages, but the headquarters remained among the Moquis. If a man was bold and courageous, and had a stout heart, and led just such a life as the order told him, and obeyed its orders, he could carry snakes in his mouth and they couldn't hurt him; but if he did not conform his conduct to such requirements, a bite from one of the snakes would be as fatal to him as to any one else." Here we seem to see the main point of the whole rite—that the snake-dance is primarily a ceremony of the Snake clan, to which the living snakes are considered to stand in the relation of patrons or kinsfolk. The present reviewer thinks this Nanahe was one of the Moquis he saw at Zuñi last year, who put his crossed fingers in his mouth to show how two snakes are held at once, describing also how, by chewing a mouthful of clay, a better grip is got of the slippery reptiles. We may fairly trust his account given here of the ceremonies of the order, the use of the four medicine-roots, the bathing and fasting, the smoking of the sacred pipe, and the ceremony with which the young men, when they catch a snake, seize it behind the head, hold it up toward the sun in their left hand and stroke it lengthwise with the right, praying to their father, the Sun, "Father, make him to be tame; make him that nothing shall happen that he bring evil unto me. Verily, make him to be tame"; then addressing the rattlesnake, "Father, be good unto me, for here I make my prayers."

Capt. Bourke quotes from *Harper's Weekly*, March 25, 1882, a description of a snake-procession in Central America considerably resembling that of the Moquis. This illustrated newspaper is not readily met with in England, but it would be worth knowing what authority there is for the account. If trustworthy, it would add another fact to the list of Central American or Mexican analogies in the Pueblo culture. Among these are the manufacture and ornamentation of the Pueblo pottery, excellently described by Col. Stevenson in the second *Report* of the Bureau of Ethnology; also the use of the *metate* or stone corn-crusher (perversely printed *metale* in this book). The description of a Moqui marriage, quoted from a Mormon bishop, which consisted in bathing the couple and then tying them together by the ends of their new cotton garments, bears an almost perfect resemblance to the well-known Aztec marriage ceremony. On the whole the new evidence which comes in as to the Pueblo Indians conforms to the judgment which Buschmann long ago formed on such scanty vocabularies as had been made of their languages. These languages he classed in the Sonoran family, not belonging to the Aztec family, but showing strong traces of Aztec intercourse and influence.

EDWARD B. TYLOR

SCIENTIFIC ROMANCES[1]

Scientific Romances. No. 1. "What is the Fourth Dimension?" By C. H. Hinton, B.A. (London: W. Swan Sonnenschein, 1884.)

THE subject discussed in this short but carefully worked out pamphlet of 32 pages, seems to be coming to the front once more. Helmholtz, in his classical paper on "The Origin and Meaning of Geometrical Axioms" (*Mind*, No. 3, July 1876), clearly states our position with regard to its representation: "As all our means of sense-perception extend only to space of three dimensions, and a fourth is not merely a modification of what we have, but something perfectly new, we find ourselves, by reason of our bodily organisation, quite unable to represent a fourth dimension."

In this article, as also in the excellent paper on "Measurement," contributed by Dr. Ball to the "Encyclopædia Britannica" (vol. xv.), many references are given to writers who have touched upon this point, but our present author has made a contribution to the subject which is independent of these writers, and puts it clearly before his readers. There are many backward glances to the inferior spaces, and here and there we find slight points of contact between our author and him of "Flatland," which show that the two were thinking of the same matter, possibly at the same time.

"By supposing away certain limitations of the fundamental conditions of existence as we know it, a state of being can be conceived with powers far transcending our own. When this is made clear it will not be out of place to investigate what relations would subsist between our mode of existence and that which will be seen to be a possible one." From a simple illustration it is shown that in our space there are three independent directions, and only three (as Helmholtz says, by the motion of a surface, a surface or a solid is described, but by the movement of a solid a solid and nothing else is described). Why should there be this limitation? He then discusses the cases of the inferior beings, which we put thus: it would be as surprising for a Flatlander to be lifted out of his closed pentagonal house and put outside as it would be to an ordinary human being "if he were suddenly to find himself outside a room in which he had been, without having passed through the window, doors, chimney, or any opening in the walls, ceiling, or floor."

The upshot of the first chapter is that beings can be conceived as living in a more limited space than ours.

A straight line by a movement at right angles to itself begets a square, but the Linelander can only conceive of movement in its straight line. The square in the same way can be made to move so as to beget a cube, yet the Flatlander has no idea of movement perpendicular to its plane. Now proceed similarly with the cube: "We must suppose the whole figure as it exists to be moved in some direction entirely different from any direction within it, and not made up of any combination of the directions in it. What is this? It is the fourth direction."

Arguing from the analogy we know, we arrive at the following results: The line has 2 points, the square 4 (angular) points, the cube 8 points, the foursquare (Mr. Hinton's name for the fourth dimension figure) 16 points; in the respective cases the lines are 1, 4, 12, and $2 \times 12 + 8$, *i.e.* 32; the plane surfaces are 0, 1, 6, and $2 \times 6 + 12$, *i.e.* 24. We get then the foursquare with 16 points, 32 lines, 24 surfaces, and bounded by 8 cubes; to us, if it were resting in "space," it would look like a cube. Of course there are other details. We pass on to Chapter III., in which are discussed the relations which beings in four dimensions would have with us. To us, of course, they would have the appearances of beings in space (as to a Flatlander a sphere appears to be a circle). "Why, then, should not the four dimensional beings be ourselves, and our successive states the passing of them through the three-dimensional space to which our consciousness is confined?" This is discussed in some detail and illustrated by means of threads. We confess to not quite following our author in his conclusion: "It is needless to say that all the considerations that have been brought forward in regard to the possibility of the production of a system satisfying the conditions of materiality by the passing of threads through a fluid plane, holds (*sic*) good with regard to a four-dimensional existence passing through a three-dimensional space. Each part of the ampler existence which passed through our space would seem perfectly limited to us. We should have no indication of the permanence of its existence. Were such a thought adopted, we should have to imagine some stupendous whole, wherein all that has ever come into being or will come, co-exists, which, passing slowly on, leaves in this flickering consciousness of ours, limited to a narrow space and a single moment, a tumultuous record of changes and vicissitudes that are but to us (*sic*). Change and movement seem as if they were all that existed. But the appearance of them would be due merely to the momentary passing through our consciousness of ever-existing realities."

The concluding chapter leads up from the inferior dimensions, and shows how, in four dimensions, the "box trick" might be effected. Some interesting illustrations from liquids and gases follow, and then, on the hypothesis of there being a fourth dimension, two possible alternatives are discussed. "If we are in three dimensions only, while there are really four dimensions, then we must be relatively to those beings who exist in four dimensions as lines and planes are in relation to us. That is, we must be mere abstractions. In this case we must exist only in the mind of the being that conceives us, and our experience must be merely the thoughts of his mind—a result which has apparently been arrived at, on independent grounds, by an idealist philosopher. The other alternative is that we have a four-dimensional existence. In this case our proportions in it must be infinitely minute, or we should be conscious of them. If such be the case, it would probably be in the ultimate particles of matter that we should discover the fourth dimension, for in the ultimate particles the sizes in the three dimensions are very minute, and the magnitudes in all four dimensions would be comparable."

We have said enough to show that the "Romance" is a curious one, and not without interest to many of our readers, to whom we commend it.

[1] For some remarks on the subject of this article, by Mr. G. F. Rodwell, we refer the reader to NATURE, vol. viii. pp. 8, 9.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

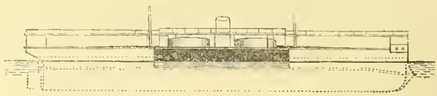
[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Relative Efficiency of War Ships

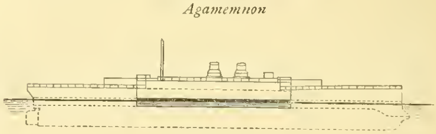
I HAVE a complaint to make against certain of the statements made in the article upon "The Relative Efficiency of War Ships," which appeared in your number for February 26. It is incorrect to declare that I advocated before the Committee on Naval Designs, in 1871, the system of construction upon which the ships of the *Admiral* class are built. The *Ajax*, *Agamemnon*, *Colossus*, and *Edinburgh* are designed upon a citadel system which I originally devised and advocated under certain limitations; but I deny, and always have denied, that any of those ships conformed to the fundamental and indispensable condition which I laid down as part of my system: viz. that the armoured citadel should be of ample dimensions to command the whole structure, keeping it afloat and upright, notwithstanding any amount of injury to the unarmoured ends. As this system has been violated in all the four ships above-mentioned, it is most unfair and improper to state that even those vessels are constructed upon a system which I advocated. But as regards the ships of the *Admiral* class they do not at all conform to the system which I advised, and the writer of the article in question could only have supposed them to do so from a serious misapprehension of the ships themselves. The article stated that the central part of all the ships in question, including the *Admiral* class, are "plated completely around with very thick armour, which extends from the upper deck to several feet below the water-line." This is a very incorrect description of the *Admiral* class, the armour in which does not rise to the upper deck at all, but is stopped in the form of a shallow belt rising but a foot or two, or possibly slightly more, above the water's surface. I repudiate with indignation the statement that such a system of construction as this, in association with the long unarmoured ends of the *Admiral* class, was ever recommended by me. For this reason I complain likewise of the statement in your article to the effect that my recent letter to the *Times* is but a continuation of the old and well-remembered *Inflexible* debate. So far is this from being so, that I distinctly pointed out in that letter that the cutting down of the armour to a mere belt of short length separated the ships of the *Admiral* class from the others, and imported "a new and terrible cause of danger." Another statement of which I complain, and which I desire to have corrected, is to the effect that I "refused to give evidence" before the *Inflexible* Committee. Were this true, it would constitute, in my judgment, a most serious ground of complaint against me, but it is not true. The *Inflexible* Report and its Appendices clearly exhibit the fact that within two days of the appointment of the Committee, and on the very day on which my evidence was asked for by the Committee, I handed in to that body a most elaborate mass of evidence, occupying no less than eighteen columns of the *Inflexible* Report, and illustrated by two sheets of drawings, this evidence setting forth in great detail my views of the subject, and the grounds of my dissatisfaction with such ships. It is true that four months later I was asked by telegram to attend the Committee, but asked to be excused on the ground that I objected to take part in the dilatory proceedings of the Committee, which I regarded as frustrating the objects with which it was demanded by Parliament. My full evidence was, however, already before the Committee, and had been for several months.

The above are the points of which I complain, and wish to have corrected. I do not ask as a matter of right, but I desire to have stated, that the long explanation which was given in the article in question for the purpose of showing that mere displacement is not, under all circumstances, a measure of the power of a ship, was, in my opinion, wholly unnecessary—at any rate, in so far as either Mr. Barnaby or myself was concerned. Both Mr. Barnaby and myself knew perfectly well that displacement is but a very rough measure of the power of ships, and no measure at all when ships of wholly different classes, and kinds, and dates, and systems are closely compared together. The only use that I made of the principle in my letter was to accept it for the moment as a rough basis of comparison between the ten latest French and the ten latest English ships, and I consider that for that purpose it was a good enough principle to indicate the inferiority of the English ships. But the acceptance of the principle for that purpose in no way precluded me from going further and showing that this rough comparison did not by any means bring to light other elements of grave inferiority, and even of danger, in the English vessels.

In the accompanying diagram the great difference between the *Inflexible* or *Agamemnon* class and the ships of the *Admiral* class is clearly illustrated. In both figures that part of the armour which is above the water is shown in full black, the part below the water being indicated by dotted lines. A glance at the diagram is sufficient to make it readily understood that the



Agamemnon



Collingwood

Agamemnon, whose side armour rises several feet above the water, can be inclined to a considerable angle before her armour is brought under the water, whereas a very slight inclination only is necessary to bring the extremely shallow armour of the *Collingwood* under the water. In the case of the *Agamemnon*, therefore, the armour she possesses affords her a considerable amount of resistance to capsizing, while the resistance thereto derived by the *Collingwood* from her armour is almost *nil*. The same remark applies, of course, to the buoyancy of the armoured out-of-water parts of the two ships, the *Collingwood* having but a small fractional part of that which the *Agamemnon* possesses.

E. J. REED

[We give insertion to this communication from Sir Edward Reed with great pleasure, because one of the chief objects we sought in our article was to support his view that the stability of the ships of the *Admiral* class under the conditions which might be expected to occur in a naval engagement was open to grave question, and to reassert that further scientific experiments should be made.

We regret that the fundamental difference, so far as *fighting* stability is concerned, between ships of the *Inflexible* and *Admiral* type, which is now brought out so well by Sir E. J. Reed's diagrams, was not emphasized in the article so strongly as it should have been.—ED.]

How Thought Presents Itself among the Phenomena of Nature

In your paper of the 5th you give a short abstract of a recent lecture at the Royal Institution by Mr. G. Johnstone Stoney, on the question "How Thought presents itself among the Phenomena of Nature." In this abstract I observe an assertion which is quite new to me, and, I must add, quite unintelligible. It occurs in the first paragraph. The assertion seems to be that there is an absolute distinction between molar and molecular motion, inasmuch as that, in the case of molecular motion there is no authority for the conviction that there must be some "thing" to be moved. The conception of motion involves the conception of matter as a necessary or inseparable concomitant—although the abstract idea of motion may, in a sense, be separately entertained. Is there any difference in this respect between molar and molecular motion? A molecule is a group of atoms, and an atom is only conceivable as an ultimate particle of matter. I hope that some further explanation may be given upon this point, which is one of the highest interest and importance, both as a matter of physical and of metaphysical speculation.

Inverary, March 8 ARGYLL

The Compound Vision and Morphology of the Eye in Insects

Mr. Sydney Hickson, in your issue of February 12 (p. 341), makes certain statements concerning my paper in the *Transactions* of the Linnean Society on this subject. I will not follow Mr. Hickson through his entire article, as I conceive it is sufficiently refuted by my paper itself. He says: "It would be tedious to bring evidence of this kind to confirm a theory which is already fully established." I would ask Mr. Hickson if anyone can explain the vision of the compound eye intelligibly on the received theory? I would also remind your readers that Prof. Huxley, writing of the crayfish in 1880, accepted the view with extreme caution; he said, "The exact mode of connection of the nerve fibres with the visual rods is not certainly made out;" that Claparède never accepted it, and Max Schultze admitted that there were grave physical difficulties in the way of its acceptance.

Mr. Hickson is very anxious, apparently, to deny me what I never claimed—*i.e.* the discovery of a layer of definite structure beneath the basilar membrane. What I do claim is the discovery of the nature of its elements. I deny, in my paper, that the optic nerve passes through these structures, and I deny that these consist of a fine reticulum of nerve-fibres. These are questions of fact and observation, not of theory or deduction. If I am wrong, I am wrong. But the way to test my work is by working out the eye as I have worked it out. I have spent nearly ten years in this work, and I do not expect to have my views generally accepted for another ten years.

The absence of pigment and retinal purple is a secondary question. I do not know, nor does any one know, whether there be retinal purple or not in this layer. I admit that pigment is absent in the retina (my retina) of some insects and crustaceans, and I have recorded the fact. I am not yet convinced that we can say vision is impossible without it. Albinos have vision undoubtedly in the absence of retinal pigment. He would be a bold man who asserted that vision could not be effected without pigment in the retinal region. The colourless collodion film of the photographer is affected; why not retinal rods? Here, again, it is a question of fact, not theory.

The presence of pigment proves nothing with regard to the function of the great rods, any more than it shows that the iris of a vertebrate is sensitive to light.

The absence of my retinal layer in Periplaneta and Nepa is imaginary on the part of my critic, for I have examined it carefully in both, and I figure the elements from the former. I maintain that the same structures exist in all the crustacea, although they are short and more difficult to demonstrate.

Again, in the morphological question my views are not fairly stated by Mr. Hickson. I admit his facts, but deny his deductions. The hypodermis forms the dioptric structures, as the epidermis of the vertebrate forms the lens; my contention is that the retina in the insect, like the same structure in the Vertebrata, is developed as an outgrowth from the nervous system.

BENJAMIN THOMPSON LOWNE

65, Cambridge Gardens, Notting Hill, W., February 23

I do not wish to undertake a lengthy controversy with Mr. Lowne on the question of the retina of insects, but I cannot refrain from making a few remarks on the letter you publish above.

I am afraid Mr. Lowne has misunderstood my criticism when he asks me "If any one can explain the vision of the compound eye intelligibly on the received theory?" My criticism was not meant for any theory of pure optics, but for the theory that the retinulæ are not the true nerve-end cells.

Mr. Lowne's statement that albinos are devoid of retinal pigment is not strictly accurate, for Kühne pointed out, and any one can see for himself, that all albino rabbits and other vertebrates possess a true retina purple. Moreover, the rods of Cephalopods and of Pecten, which seem to be devoid of pigment in spirit specimens, possess, as Hensen has pointed out, a true retina purple. In fact, I know of no exception to the rule I laid down—namely, that optic nerve-end cells are pigmented, and I should be glad if any of your readers could point out any exceptions to it.

Mr. Lowne's reiterated statement that the optic nerve fibrils do not end in the retinulæ is, as I said, contrary to my own observations. I have submitted my preparations to several eminent naturalists, who agree with me in my account of their distribution. I shall be happy to submit them to any others who may feel interested in this matter.

The other statements in my notice which Mr. Lowne controverts I will not refer to again here, as they will be fully explained and illustrated in my forthcoming paper in the *Quarterly Journal of Microscopical Science*, the proof-sheets of which I have now in hand. SYDNEY J. HICKSON

Anatomical Department, Museum, Oxford, February 25

Civilisation and Eyesight

In connection with Lord Rayleigh's letter in NATURE, p. 340, on the above subject, I venture to hope that the following may be of interest:—

In the "Expression of the Emotions" the late Mr. Darwin quotes some observations—if I recollect correctly—by Gratiolet tending to show that, under the influence of *fear*, the pupils of animals' eyes dilate. Observations extending over some years have convinced me that fear is undoubtedly capable of thus causing dilation of the pupils (see Dr. Hack Tuke, "Influence of the Mind on the Body"); and in general literature, such as travels, novels, &c., I have met with many instances in which the eyes of both men and animals under this condition have been so described by the writers.

Is dilation of the pupil under the influence of fear to be explained on the assumption that the increased aperture of the eye enables a more effective scrutiny of the object causing terror, and has thus been of service in the struggle for existence?

An answer to this question is not easy to give, for, although dilation of the pupil under the influence of fear may have originally been of direct service to an animal, yet this condition may in time have come to be associated with other emotions in which it is not so easy to trace any such direct benefit.

Observations upon the subject are by no means easy (varying light, for instance, varies the aperture of the eye), but in the course of my observations I became much inclined to believe that other strong mental emotions besides fear (*e.g.*, joy or pleasure) may be capable of giving rise to dilated pupils.

Charlotte Brontë, in "Jane Eyre," is one of the only writers who associates a dilated pupil with other emotions than fear. Here is the sentence:—"Pain, shame, ire, impatience, disgust, detestation, seemed momentarily to hold a quivering conflict in the *large pupil dilating* under his ebon brow."

It is to be feared that the experimental investigation of eyesight with artificially contracted or dilated pupils is scarcely practicable, for drugs, such as atropine or eserine, act not only on the pupil, but also on the power of accommodation for distance. J. W. CLARK

Liverpool, February 21

P.S.—I see Dr. M. Foster, in his "Text-Book of Physiology," mentions the dilation or contraction of the pupil which attends the adjustment of the eye for distant or near objects respectively, and also its dilation "as an effect of emotions." It thus seems highly probable that strong and very different mental emotions may give rise to dilated pupil. Dr. Herdman has suggested to me, as an explanation of this, that an intens

excitation of one brain centre may possibly act in the same way as a direct inhibitory impulse by partially paralysing an adjacent centre.

The Forms of Leaves

THERE are several points in Sir John Lubbock's lecture (NATURE, February 26, p. 398) which seem to invite some little criticism. That "the size of the leaf . . . is regulated mainly with reference to the thickness of the stem" seems somewhat self-evident, as a large leaf must have a large stem to carry it, as, *e.g.*, may be seen by comparing the slender shoot of a Deodar with a cabbage-stalk; but he adds: "The size once determined exercises much influence on the form." This is a *deduction* which seems to require *verification.* Sir John gives the area of a beech-leaf as about 3 square inches, but the form remains the same whatever the size. Size rather depends on vigorous growth, as in the following instances: *Populus alba* leaves on a vigorous basal shoot were $6\frac{1}{4} \times 3\frac{1}{2}$ inches, the diameter of the shoot being $\frac{1}{4}$ inch; on the upper branches of the same tree many leaves were only $1\frac{1}{2}$ to $2\frac{1}{2}$ inches long, the diameter of the shoot being also $\frac{1}{4}$ inch. Similarly growing oak leaves of the same shape were 6×3 inches and $2 \times \frac{3}{4}$ inches respectively. An *Aucuba japonica* bore rounded leaves on a basal shoot $4 \times 3\frac{1}{4}$ inches, but those on the stem were 4×1 inch. In this case, as in other plants with (normally) dimorphic leaves, as ivy, it is difficult to see what connection there is between size and form. Indeed leaves of every degree of superficial area can be found amongst the lobed ones on the climbing stem of ivy, and the entire ones of the flowering branch. Sir John adds that "the form of the inner edge [of the beech] . . . decides that of the outer one." He does not seem to have verified this deduction. The two edges are symmetrical in this leaf, but they are not so in the elm and lime. How will the inner edge explain the cause of their obliquity? If, however, the *buds* of the lime be examined, a more probable cause (as it seems to me) will be discovered in the conditions of development. He describes the *Eucalyptus*, when young, as having "horizontal leaves, which in older ones are replaced by scimitar-shaped phyllodes." Bentham and Hooker say of *Eucalyptus*: "Folia in arbore juniore sæpe opposita, in adulto pleraque alterna," but makes no mention of phyllodes. Speaking of evergreen leaves, he says: "Glossy leaves have a tendency to throw [snow] off, and thus escape, hence evergreen leaves are very generally smooth and glossy." This sentence appears to imply that such leaves are glossy in anticipation of snow! a deduction which certainly requires verification. Again: "Evergreen leaves often have special protection . . . by thorns and spines. Of this the holly is a familiar illustration; and it was pointed out that in old plants above the range of browsing quadrupeds, the leaves tend to lose their spines and become unarmed." The inference the reader draws from this is that when the holly grows out of reach of browsing animals it has no necessity to produce prickly leaves, and so changes them accordingly, thereby implying that unarmed leaves were in some way preferable. This is another instance of deductive reasoning which requires verification, for it seems to be attributing to the holly a very unexpected process of ratiocination! But it is not at all usual for hollies to do this. I have several from six to nearly twenty feet high, and not one has borne an unarmed leaf. Though my cows do not touch a holly hedge, yet one young bush lately planted has taken their fancy, and they have bitten it all to pieces. On the other hand one bush (in the garden), a variety with unarmed foliage, occasionally throws out a branch with prickly leaves, though the cows are not admitted where it grows.

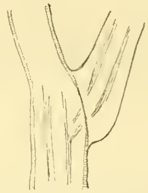
"Fleshy leaves were principally found in hot and dry countries, where this peculiarity [*sic*] had the advantage of offering a smaller surface, and therefore exposing the plant less to the loss of water by evaporation." Surely the usual explanation, that it is the thick cuticle which prevents rapid exhalation is a better reason than Sir John's deduction from the small size of the leaves? Speaking of aquatic plants, he says that the submerged "cut up" leaves of such plants presents a greater extent of surface;" and adds that "such leaves would be unable to support even their own weight, much less to resist any force, such as that of the wind.." I should be glad to know if he has verified the first statement by actual measurements; for an *à priori* assumption leads one to fancy that a complete leaf would have a greater surface than one represented by its ribs and veins only. With regard to the second and third statements a "natural experiment" completely refutes his deduction, for I know a place where a small pond dried up last summer, and a large portion of the ground was covered with a dense velvet-like carpet, composed of the *erect* filiform branchlets of the "cut-up" leaves of *Ranunculus aquatilis*, which had become modified by their new medium, and perfectly adapted to enjoy an aërial existence.

In offering these few criticisms for Sir John Lubbock's consideration, I would venture to remark that he seems to have followed too closely in the deductive methods of another writer on leaves, and which called forth the following remark from Prof. Lankester:—[He] "gives us hypotheses, suppositions with insufficient evidence, and deductions from the generalisation of Evolution, but he is relatively deficient in 'verification'" (NATURE, vol. xxviii. p. 171). GEORGE HENSLOW

Drayton House, Ealing

The Fall of Autumnal Foliage

MR. FRASER alludes to "the unpursued inquiry into the cause of leaves falling in autumn" (NATURE, February 26, p. 388), and I do not find it mentioned in Sach's "Text Book"; but Dr. Masters, in Henfrey's "Elementary Course of Botany," fourth edition, p. 515, speaks of "a layer of thin-walled cells being formed across the petiole," but does not say whence this layer is derived. Duchartre, however, gives a pretty full account of opinions up to 1877 ("El. de Bot.," deux. éd. p. 443), which he reduces to two, *viz.* Schacht's, who attributes it to a growth of periderm, and that of Mohls, who recognises a special layer which he calls *couche séparatrice*, considering the peridermic layer as being often, but not always formed. Subsequently, M. Ledgeganck



examined different plants and corroborated Schacht in regarding the periderm as the *cause prédisposante*, and cold to be the *cause efficiente*, which contracts "le tissu de la base du pétiole, spongieux, aéré, élastique à un degré beaucoup plus considérable que celui du coussinet." From my own observations on the horse-chestnut, ash, &c., it appears to be in these clearly a continuation of periderm produced by the phellogen of the branch, which invades the base of the petiole, till it meets in the middle, cutting right through the fibro-vascular bundles of the petiole. As this suberous layer dies, the leaf necessarily falls off. But as long as a leaf is in vigorous health it would seem to resist this invasion, and last longer, as do evergreens. I inclose a figure I possess of a slide showing the process in the horse-chestnut.

Drayton House, Ealing GEORGE HENSLOW

Forest-Trees in Orkney

IN NATURE of February 26 (p. 388) Mr. A. T. Fraser says that "a peculiarity of Caithness and the Orkney and Shetland Islands is that no forest-trees can be got to grow," and he proceeds to explain this by the preponderance of polarised light. As far, at least, as Orkney is concerned, I am prepared to rebut this calumny. It is true that forest-trees are not the striking feature of the Islands, but they do occur. At Binscarth, between Kirkwall and Stromness, there are willow, ash, sycamore, and Scotch fir. They require to be protected—from the wind, I presume, and not from the light—by hedges of bour-tree (elder). In the street at Kirkwall itself there is a fair-sized sycamore.

Trinity College, Cambridge JAMES CURRIE

YOUR Indian correspondent, Mr. A. T. Frazer, can hardly be acquainted with the primitive jungles of Southern India, or he would have observed that there, at one and the same time, the aspect of all the four seasons is displayed in the vegetation.

When in Coorg, in two different years, during the months of January and February, we not unfrequently drove up to Mercara, the capital, a distance of ten miles from the place where we were staying. On the way thither we saw some trees in their winter condition with perfectly bare branches, others had the tender foliage of spring, some again were in all their summer glory, and some were clothed with the most brilliant autumnal tints; this was most probably due to the great variety in the species of trees in that district. COSMOPOLITAN

A Tracing Paper Screen

As several inquiries have been made of me as to where the proper tracing paper can be obtained, perhaps I may be allowed to state that I got mine through Mr. George Smith, 26, Colebrooke Row, City Road, N., who was the first, I believe, to recommend the use of this valuable material.

CHARLES J. TAYLOR

Toppesfield Rectory, Halstead, Essex

GEOFFREY NEVILL

WE have to announce the comparatively early death of Mr. G. Nevill, which took place at Davos Platz, after a long and lingering illness, on February 10. This removes from among us another of the scanty band of English conchologists, whose ranks, only a few days before, suffered a similar loss in Mr. J. Gwyn Jeffreys. Mr. Nevill's labours have been principally confined to India, where he was for many years one of the assistant-superintendents under Dr. J. Anderson in the Indian Museum, Calcutta; his work is, therefore, better known to those who have collected in the East and written on the molluscan fauna of that part of the world. For many years he was a constant correspondent and colleague of the writer's, who can testify to the large and varied knowledge Mr. Nevill possessed of the different forms. A very large number of species were sent him by Mr. Nevill from time to time, many of which still remain to be described. Mr. Nevill was the author of many papers on his favourite study, most of which are to be found in the *Journal* of the Asiatic Society of Bengal; but perhaps his best and most useful work, particularly to those interested in distribution, was the "Hand List of Mollusca in the Indian Museum" (Part I. comprising the Pulmonata and Prosobranchia-Neurobranchia published in December, 1878, and is remarkable for the accuracy with which the localities of the different species is given, and the collections from whence they were received. He also catalogued the Ampullariacea and Valvatidæ and Paludinidæ). Unfortunately, the whole catalogue of the Gastropoda is incomplete, for his health failed him altogether in 1881. Yet he struggled on to the last with his task, even when unable to leave his room to go as usual to his office in the Museum, and was compelled eventually to give up his appointment and return to Europe. The entire arrangement of the Mollusca in the new Museum formed a part of his work when there, and it was well and admirably done. Almost his last work in the field was at Mentone, in 1878-79, where, in the post-Tertiary beds, he made a careful collection of the shells, particularly the smaller species, a list of which he published in the Zoological Society's *Proceedings*. Yet even so late as last summer, when hardly able to move from weakness and partial paralysis, he was getting together the land-shells to be obtained in the country around the Lago de Como.

Geoffrey Nevill was born at Holloway on October 5, 1843; he was the second son of Mr. Wm. Nevill, F.G.S., who resided for many years at Langham Cottage, Godalming, a gentleman who made mineralogy his study, and whose collection of meteorites was well known. As is often the case, his son inherited kindred tastes, for, when quite a boy, his attention was directed to shell-collecting both in Germany and in England. Most of the English species in the Calcutta Museum originally formed a part of this collection, and bear labels from near his early home at Godalming. He received his education at Dr. H. D. Heatley's school at Brighton, and afterwards spent some time at Bonn in the house of Dr. F. H. Troschel, Professor of Zoology, and this no doubt confirmed his early taste for natural history and directed his future career.

He was never strong, so, after entering into mercantile life in his father's house, and his health breaking down, he was ordered abroad, and he proceeded to the Cape, the Mauritius, and Bourbon, where he collected largely, and formed a valuable and rich collection. Some of the results were described in joint papers by himself and his brother, Hugh Nevill, of the Ceylon Civil Service. He went on to the Seychelles Islands in 1868, where he remained some time, still further enriching his collection, and then went on to Calcutta. At this time an appointment offered itself in the New Museum, which he took and filled for many years. Here in Calcutta during this period a little band of workers in conchology were drawn together, most of whom were employed on the different surveys of the country. Season after season, on return from the field, the results of their labours in every part of India accumulated and were examined. Ferd. Stoliczka, one of the first to be removed, was one of the most ardent workers, and all benefited from his deep, more advanced knowledge of the subject.

The survivors will recall those pleasant intellectual gatherings when they hear of Geoffrey Nevill's death, and future students and collectors of Indian Mollusca will appreciate the work he lived to perform, and which will render their work in the galleries of the museum in Calcutta more easy.

REPORT OF THE COMMISSIONER OF EDUCATION IN THE UNITED STATES FOR THE YEAR 1882-83[1]

IT is impossible to read the account which the United States Bureau of Education, in the opening pages of this Report for 1882-83, gives of itself and of its labours, without being convinced of the value of the matter therein contained. A total of over 10,000 institutions of education of various kinds are in correspondence with, and supply information to, the department. An idea of the work also which falls to it may be formed from the fact that some questions addressed to it have necessitated months of research by several clerks, while the labour which its publications have entailed, as well as the value placed upon them, are shown by the fact that one of them was *asked for* by 10,000 persons of different addresses. Since all is voluntary, the Bureau claims to work the most complete system of the kind in existence. The wide compass of its survey is indicated by the very full account given, among other foreign intelligence, of the Report of the English Commission on Technical Edu ation. Besides itself circulating through the world 20,000 copies of its Report, the office is require dto print 18,000 copies more for the use of, and distribution by, other members of the Government. Its library—where all the items of information which it is possible to collect, down to cuttings from newspapers, are gathered together and classified—is an immense work: and we can well believe that, "if this office were put in possession of a small sum annually for the purpose, it would make effective and useful displays at exhibitions, of American education . . . the most unique feature of our national life."

The report of this education generally is far more satisfactory than in other years. There has been a general increase, first in the number of scholars, even in Maine where the population has become smaller, and in New Jersey, New Hampshire, Connecticut, South Carolina

[1] Washington Government Printing Office, 1884.

and Kansas, where schools have become fewer. Though the contrary might have been expected in an increasing country, a great complaint of the Report is the multitude of small schools which require consolidating for the sake of employing better teachers and apparatus. The suggestion is made that each State should fix a minimum of salary to be paid to any teacher; this not only must be good for the children, but would of itself urge forward the consolidation, where distance allowed it, of small schools of less than ten or twelve scholars.

In Rhode Island, and in city schools generally, the competition of factories is lamented. The deficient average attendance is imputed to the demand for cheap labour; and obligatory laws are quoted, among other things, as an antidote. It should not be forgotten that the inexorable enforcement of those laws is what is in reality the greatest kindness to poor families; for if the cheap labour of young untaught children once enters the market in the smallest quantities, it becomes impossible to gain a fair price for the work of those older and better taught. But, protected from all such unfair competition, the child's education becomes a common necessity. No doubt the difficulty is much felt in Alabama, North Carolina, Louisiana, and Mississippi, the only States whose reports are generally unsatisfactory: States where negro labour keeps down the wages of white children.

There has been an increase, again, in the number of teachers: with regard to which it is interesting to note that in three States the number of men has fallen off, while in them, and even in frontier States, that of women has increased: and an increase also in the item of teachers' salaries; even in Illinois with fewer of them, in Indiana, where the population has decreased, and in Michigan, where in past years the amount had fallen off.

The variation in different States of the expenditure on education, however, is still exemplified in the fact that Massachusetts pays fifteen times the amount per head that Alabama pays!

The educationists of Kentucky, where whites and blacks are treated alike with regard to schooling, appeal to the Peabody Trustees for advice to the Legislature. This latter body, who are gaining an influence like that of our Charity Commission, have concentrated their money upon training teachers, with successful effect over school work in the south. Another benefactor has bequeathed over 700,000 dollars to the whites of New Orleans for educational purposes.

The improvement in the organisation of systems, the greater efficiency of work, and the deeper interest felt by the people, is indicated by the public schools in some States superseding the private ones; and Gen. Eaton attributes to the influence of the superintendents (officers whom we have before quoted as combining the knowledge of our inspector with the zeal of our chairman of School Board) the two most promising general movements now going on, viz. the increase of local taxes for education in the Southern States, and the effort to abolish small independent, irresponsible districts in the older Northern States.

Still, nothing can be more depressing than that, in a community naturally the leading people of the world, a sober report of a patriotic commissioner should still find it necessary to say more than once in his Report, that a work so all-important to the future of that community as education should be marred by school commissioners persisting to license the cheapest teachers they can procure, and using the license as a means of favouring relations, political supporters, and such like; thus rendering useless the efforts of examining bodies, who have pointed out the really competent persons for this most responsible office.

We have no need to enlarge again here upon the United States difficulty, the education of the negro. The burning question of course is, Who is to pay for it? The Report speaks confidently of securing national aid, the need of which has been so strongly urged before. One gentleman gave 1,000,000 dollars towards the work, but religious denominations have so far been the great supporters of black education.

We, in England, can better enter into the labours of those who are trying to raise the street Arabs to a generally higher level. Few things ought so much to convince anxious reformers how little their improvements depend upon the form of government, as to see how the struggle of the poorest for existence is as sharp and demoralising in the large towns of the United States as it is in England. One of the leaders of the Kindergarten system lays it down that "the best energies of the faithful teacher are often required when the work of the schoolroom is over. There is much visitation to be done to look up absent children, and, where sickness invades, the teacher is often called upon to supply medical aid and other necessary help; and, where death ensues, there is sometimes no one but the Kindergarten helpers to see the little one decently buried;" and, in fact, not only to take all the duties and responsibilities off the hands of parents, but to provide an antidote to their mischievous example and teaching. Their success in many cases must lead its supporters on to the venerable yet now radical proposition, which will be most offensive to Mr. Herbert Spencer, that education from infancy should be the work of the State; and, strange as such a suggestion must seem among English homes, it is very much in harmony with modern division of labour which makes the parent less able to educate, in the full meaning of the word, a family, and the professional Kindergartens so much more so. And the same principle is to be traced in the recommendation that homes, as well as training-schools, should be found for nurses.

Both in primary and secondary schools witness is borne to the improved teaching. The importance to the former of the example of good teaching to be found in the normal schools, as well as the precept on the subject, is fully insisted upon; a difficulty often met with being the work of correcting bad teaching in the lower schools: while, on the other hand, the multiplication of teachers well trained in public normal schools is, as we have said, urged as the surest, and, in the long run, the most economical means of raising the standard of education throughout the country.

Examinations like our Oxford and Cambridge Locals, held by the regents of New York, are leading to greater uniformity in the teaching of the second-grade schools.

Perhaps the most striking thing in the Report is the important part which women are now taking in study, as well as in teaching, in the United States. The demands and attractiveness of commercial life to the young men of America, with the energy and self-reliance of its women, are leading to the result that the latter are becoming the learned class there. We have already remarked upon the large and increasing proportion of female teachers in all the elementary schools. But, moreover, while twice the number of women begin a high school course, three times as many women as men complete the fourth year. Although the increase is not large this year, there are over 40,400 women in institutions of superior instruction. At Purdue University, where practical mechanics is taught, a number of young ladies have been among the special students, and "have done the same work as the young men, and, though progressing much slower, have been nearly as successful." Educated women are now also the leaders of many philanthropic movements.

The education of the blind and the feeble-minded is urged as a matter of public economy, their cost if left uncared for amounting to much more. The same considerations have many times been urged in favour of reform schools. But they are all attempts to counteract laws of nature that all these diseased specimens shall be inexor-

ably extirpated, and it is hard to see a satisfactory result of these efforts in the long run. A singular mischief has recently been commented upon by Prof. Graham Bell (see NATURE, No. 795, arising from the system of teaching deaf-mutes a language and literature, intelligible among themselves, but not familiar to the general public. Hence they prefer their own society, and are trying to form deaf-mute settlements which must result in hereditary transmission to the whole community of this terrible degeneracy. It will be a curious experiment if allowed to take its course.

A most healthy sign of the times is that the increase of students at the schools of science is far larger than the increase in the number of establishments. It shows a general appreciation of their work, and in an enterprising country like America will soon bring about an increase in the number of schools. Institutions are becoming more general which undertake to train students for the higher schools of science. The cost of laboratories and apparatus and the scarcity of teachers are two of their difficulties, indicating at the same time the high standard of work they aim at. We note with pleasure that the sole purpose of the Wisconsin Agricultural Experiment Station is the discovery of new truths and laws which may be of benefit to agriculture, and farming is taught there as a scientific pursuit. In the Storrs Agricultural School at Mansfield, Conn., though of less ambitious character, "students receive instruction both in the class-room and on the farm. In the class-room they study those branches of natural science which have a directly useful bearing on New England farming, such as general and agricultural chemistry, natural philosophy, farm mechanics, surveying, botany, zoology, geology, animal physiology, mineralogy, and theoretical agriculture, stock-breeding, and composition. The general principles of these sciences are taken up first, and afterwards their special applications to practical agriculture, which includes the improvement of the soil by tillage, draining, manuring, and irrigation; the culture and handling of the various field, garden, and orchard crops of New England—grass, grain, roots, vegetables, and fruits—from planting to market; the use, care, and repair of farming tools, implements, and machines; the breeding, rearing, training, and feeding and use of live stock; the best methods of dairying, the business and management of the farm in all its details. . . . The intellect being called into play, farm work is divested of its monotony and robbed of the repressive influence derived from it when viewed as mere physical labour."

It is well urged in favour of an institution like the St. Louis Manual Training School, that through the minute division of labour which necessarily attends our increased machinery, the old method of teaching a trade is rapidly and inevitably disappearing; that it is only at a technical school that the *toute ensemble* of a trade can be learned so as to be intelligently carried on and fresh inventions led to; that there is an idea afloat that it requires no education to be a mechanic, and hence the despising of both craft and craftsman, whereas the thorough understanding of both theory and practice of a skilled industry makes its owner "the peer of the statesman; and from the union of his head- and hand-work come a large part of the civilising agencies of the nineteenth century."

The English Commissioner on Technical Education reports on the efficiency of the American workman, which is mainly attributed, by all who have inquired into the subject, to the primary education acquired, by them during a prolonged attendance at school, and now the idea is to be traced through all the Report upon the subject, that to teach the pupil his trade should henceforth be the work of a school; as much one part of education as the three R's the other part.

And not the work of a primary school only, but it is even urged that it should be the work of the Universities to send forth young men, fitted by technical training to lead in the development of the State; its fields, mines, quarries; its railroads and water-power; its manufactures and commerce." And already at Cornell University, as well as at Massachusetts Institute of Technology, electrical engineering is taught sufficiently extensive to prepare a man for ordinary electric work or advanced study. To Terre Haute, Ind., a small town of 26,000 inhabitants, the splendid legacy of a property bringing in 25,000 dollars a year was left for a technical school, in the starting of which great care as well as energy have been shown.

Very different, however, from these buoyant views is the record to be found also in this Report, that in Austria the higher schools for technical instruction have been decreasing for the last few years.

Nor again is science only, but art also in its more marketable shapes is becoming rapidly the work of schools. A public art school, under the direction of Mr. C. G. Leland, has been trying an experiment as to what children, nine-tenths of them from thirteen to fifteen years of age, could do in the way of art manufactures by being taught designing and art processes. Besides developing inborn talent, this school not only finds a commercial value in their productions, but insists upon what is becoming generally observed, that technical teaching, though shortening school hours for other work, by no means reduces the amount of progress made in the latter, brighter wit and interest being excited by hand-work at intervals with head-work. Elsewhere in the Report a protest is quoted from Harvard University which will be re-echoed from the breast of many an English *paterfamilias*, against athletic sports being made too much a business or profession, instead of a recreation. Besides the waste of time which, it is urged, might be given to other things, such a standard of excellence as the few attain makes the game very exclusive and confined to a small number. Of course we know the reply often made to this, viz. that the best players are also the best workers; but do not these simultaneous experiences strongly suggest that some technical art might take the place of a dangerous game, thus infusing intelligence into the former, and providing the student with a means of competency in case of reverses? Many arts are more intellectual and less laborious than football or agriculture as carried on at Rugby, England, or Rugby, Tennessee.

The unsatisfactory condition of the medical profession in the United States, which has been remarked upon in previous reports, is in this one traced back to the thinness of population a century ago; a population also of vigorous physique occupied in clearing and settling an enormous territory, and free from most of the diseases that afflict humanity of lower vitality, and under less favourable circumstances. The early colonial physician often combined other functions with those of healing: sometimes he was a minister of the Gospel, sometimes a farmer, a shopkeeper, or a mechanic. The bulk of the profession at the beginning of the century, and for many years afterwards, did not possess any medical degree. The result followed that men of natural boldness revolted against the frequent ignorance and numerous errors of such physicians, and became followers and advocates of special medical doctrines, and supported the "botanic" school of practice, that of Hahnemann—hydropathy, physiopathy, vitopathy, electropathy, or other "medical heresies." Degrees have been too easily obtainable through numerous schools competing for popularity, and offering them for little money and less work, with the natural result of their being little valued. The Report, therefore, after going largely into the subject, and deprecating the present state of things, urges fewer schools and higher degrees, which will be worth jealously guarding, to be given by State-appointed examiners only, on the attainment of a much higher standard. Since we are told that ten colleges have agreed upon a uniform entrance examination to the great help of masters pre-

paring boys for their studies, it may be hoped that a more general union may be arrived at with regard to this standard.

Free libraries are still progressing, and so interesting are the statistics of these "universities of the people" in the United States, that Gen. Eaton promises a special publication on the subject, reprinting such parts of the great Report of 1877 as have permanent value. Several magnificent bequests and donations of books to large libraries show how naturally large private collections will gravitate to the free public library, where the locality is happily provided with one. One such, that of Dr. Toner's, containing 27,000 books and 12,000 pamphlets, was thus bequeathed to the Library of Congress. This latter institution, at the end of 1882, already contained 480,076 volumes and 160,000 pamphlets, and the forthcoming plan of a new building to keep in utilising order this rapidly growing mass is intended to embody the best appliances, arrangements, and ideas about library construction which such enormous accumulations render indispensable. An excellent precaution also against knowledge being locked up in over-large supplies of literature is taken at Chicago, where Dr. Poole, the great cataloguist, receives schools or teachers on a Saturday, surrounded by all the books of the library bearing upon some matter. By showing how interesting that subject is as a department of human thought and industry, and how much the contents of the library may help the student to a knowledge of such a subject, he has succeeded in producing a profound beneficial effect upon the upper grades of the school system. W. ODELL

BIRDS BREEDING IN ANTS' NESTS

THE following communication to Mr. Grant Duff, Governor of Madras, has been forwarded to us for publication by Sir John Lubbock:—

To Major Awdry, Private Secretary to His Excellency the Governor of Madras

OOTY, *January* 18, 1885

SIR,—I beg to acknowledge your letter of yesterday's date.

The Southern Chestnut Woodpecker (*Micropternus gularis*), always, as far as I have observed, uses an ants' nest to nest in, and Mr. Gammie, the Superintendent of the Government Cinchona Estates at Mongphoo, near Darjeeling, has noticed the same thing with regard to the allied northern species, *Micropternus phaloceps*, and the peculiarity probably extends also to the allied species found in Burmah, Siam, &c.

Mr. Gammie thinks that when an ants' nest has been taken possession of by the bird that the ants desert the nest. This is a point on which I cannot speak with certainty. Mr. Gammie has taken nests of the northern species in which, although the bird had laid, the ants remained, and he has taken other nests where not a single ant remained; but there is nothing to show that these nests were not deserted before the bird took possession. I myself have taken nests of the southern form, in which, though the eggs were partially incubated, the ants remained, showing that some considerable time must have elapsed since the bird took possession. This is a point that I hope to be able to elucidate within the next few months, when the birds will be breeding.

When *Micropternus* is breeding the feathers of the head, tail, and primaries of the wings get covered with a viscid matter, having a strong resinous smell, and this substance is usually rather thickly studded with dead ants (*vide* "Stray Feathers," vol. vi. p. 145).

Two species of kingfishers also to my knowledge nidificate in ants' nests—viz. *Halcyon occipitalis*, confined to the Nicobar Islands, and *H. chloris*, which ranges from India as far south as Sumatra.

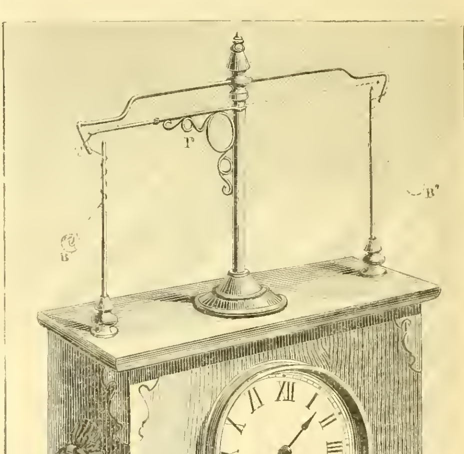
At Mergui, in South Tenasserim, I found a nest of *H. chloris* in a hornets' nest, and although I saw the birds repeatedly enter the hole they had made in the hornets' nest the hornets did not seem to mind it, but they resented in a very decided manner my attempt to interfere with the nest.

I am sorry I cannot give His Excellency more certain information as regards the desertion or otherwise of the ants from their nest after the birds have taken possession of it, but I hope to be able to finally settle the question shortly.

I am, Sir, yours obediently,
(Signed) WM. DAVISON

A NEW AMERICAN CLOCK

THE accompanying figure from *La Nature* illustrates a new American clock of ingenious construction. It is distinguished from all other clocks by the singular and original form of its pendulum: or rather of the system which serves to maintain a synchronism more or less perfect between the passage of time and the indications on the dial. The arrangement of this clock is based on



the principle of torsion. It has to be wound up daily, and the phase of the pendulum—that is to say, the time which elapses between two identical positions of the regulating system—is six seconds. The general mechanism does not differ from that of ordinary clocks; we find the main spring and other usual parts, and a train of wheels giving rotation to a vertical axis which is seen over the case and the rate of motion of which is to be regulated.

Here the new mechanism comes in. This vertical axis supports a sort of bracket, P, to the extremity of which is attached a small bead or ball, B, by means of a thread a few centimetres long. Putting out of view meantime the other parts resting on the case, it will be seen that the axis, by the action of the main spring, will turn with a rapid movement, drawing the ball B along with it. To regulate this movement, it is sought to interpose in its path suitable obstacles; this is the object of the horizontal wire terminating in the hooks T, and of the vertical pillars fixed on the case. The bracket P draws the thread in its movement and makes it strike against the arm T; it is thus arrested, and by virtue of its acquired speed, the ball B winds the thread around the pillar on the left; then follows an unwinding of the thread and a rewinding in an inverse direction, which enables the thread to pass the point T. But in unwinding it strikes a second time against the pillar, winds and unwinds anew, and only succeeds in passing this double obstacle after four successive windings, twice in one direction, and twice in the opposite direction around the same pillar. The thread thus set at liberty permits the bracket to turn 180° around the vertical axis. After this rotation it encounters two analogous objects placed on the right of the clock, and is delayed a certain time before passing these objects and returning to the pillar on the right. By suitably varying the length of the thread, which is easily done by means of a runner on the bracket, we obtain the complete phase of the movement with its eight successive windings of the thread, lasting exactly six seconds; and the clock is thus regulated, if not with all the precision of a chronometer, with an approximation said to be sufficient for ordinary use. The principle applied in this clock might possibly be utilised in cases where it is sought to regulate a slow movement of rotation by simple arrangements, both economical and uncumbrous.

A CLOUD-GLOW APPARATUS

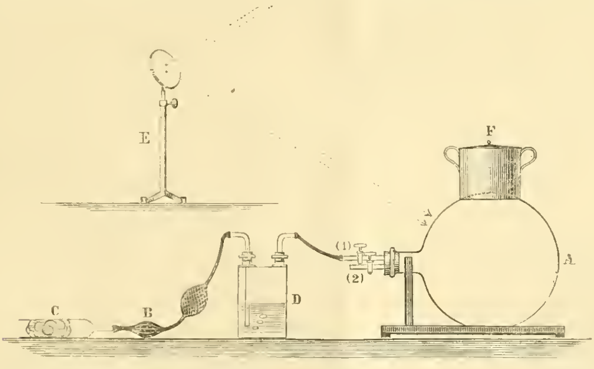
By the kindness of Prof. J. Kiessling, of Hamburg, we illustrate a simple and easily arranged piece of apparatus which he has designed for the purpose of exhibiting on an experimental scale some of the many colour-phenomena which are produced when direct sunlight, or electric light, penetrates a moist or a dry cloud. In particular the apparatus can be used to produce on an artificially excited mist the same kinds of intense colorations which were visible in such extraordinary brilliancy in the winter 1883-84 during the hours of twilight at almost every place the whole world over.

The following pieces compose the apparatus:—

1. A glass globe, A, Fig. 1, holding about 20 litres, fixed in a wooden support, and closed by a rubber stopper bored with two holes. Through these holes enter two tubes of glass (1) and (2), with taps ground in.

2. An air-filter, C, consisting of a glass tube 30 centimetres long, filled with cotton-wool.

3. An india-rubber pump, B, for producing spray or mist. This is simply part of a common spray-apparatus, and is set so that it draws air from the air-filter and delivers it into the globe. By this means a pressure of one-sixth to one-fifth of an atmosphere is readily obtained. Suppose 15 or 20 grammes of water to have been introduced into the globe and such a pressure to have been produced, and then after about 10-15 seconds the other tap (2) to be suddenly opened, or removed quite out of the tube, the release of pressure will result in a sudden



lowering of the temperature, and the production of a tolerably homogeneous mist, the density of which will depend on the quantity of aqueous vapour present.

4. A simple heliostat, E, consisting of a mirror capable of being turned either in altitude or azimuth on an iron stand, and also of being clamped at any desired height.

5. A Woulff's wash-bottle, D. This can be filled with hot water so as to yield a supersaturated atmosphere; or, by the addition of ammonia or of hydrochloric acid, may furnish vapours of these materials for experiment in the globe.

6. A cylindrical tin-ware vessel, F, with a spherical bottom, to be set upon the glass globe, to heat or cool it as may be desired.

The following experiments may be made with this apparatus:—

[1] *The Ordinary Lunar Halo.* First cover the surface of the mirror with a card disk having a central circular opening 2 centimetres in diameter, covered with tissue paper. In direct sunlight observe the bright surface of this circle of tissue paper (which serves as an artificial moon) through the mist that is produced in the globe by letting in a stream of moist vapour from a flask of hot water for a few seconds. The halo is yellowish with a red-brown edge.

[2] *Blue Sun.* Pour into the globe a little hydrochloric acid, and blow in air through the wash-bottle, having filled the latter first with liquid ammonia. A dust-cloud of fine particles of sal-ammoniac is thereby produced. A ray of direct sunlight viewed through this is curiously coloured, appearing at the first moment red, and then changing to bluish violet and to full blue.

[3] *Artificial Cloud-Glow.* For producing the intense diffraction colours of the cloud-glow it is necessary to procure a cloud consisting of small particles all about the same magnitude. This is best attained if the air before entering the globe is first led through hot water. If the conditions are favourable the colours are sufficiently intense as to permit of their being received on a white screen one metre distant. The colours change rapidly in a regular gradation of order, each colour appearing first at the centre of the field, and moving outwards.

Several additional phenomena are to be observed with this apparatus; and its inventor has devised an ingenious proof of the once-disputed point that the particles of mist are spherules, not vesicles. This he does by showing that certain diffraction phenomena which depend on the size of the particles remain unchanged during a sudden change of external pressure, which, if the particles were bubbles or vesicles, would at once cause them to expand.

ILLUMINATION OF MICROSCOPES AND BALANCES

IN measurements and weighings where high scientific accuracy is needed it is sometimes necessary to use artificial means of illumination, and it is found that when reflected light cannot be conveniently introduced, the heat from ordinary lamps causes variations of the temperature of the room, &c., which slightly affect the accuracy of the results to be obtained. By using, however, an incandescent electric lamp fitted inside a glass vessel of water, the light may be even brought near to the microscope or balance without any appreciable interference with temperature. The glass vessel is provided with a pierced cover or shade, and a little stream of water of a uniform temperature may be kept flowing through the vessel.

By means of a "chromozone" battery, supplied by Mr. O. March, it has been found, at the Standards Office, that a light may be maintained at an insignificant cost for fifty hours without, of course, any attention. During a recent comparison made by Mr. Chaney of two standard kilogram weights it became necessary to use the lamp, but the action of the balance was not interfered with by the proximity of the lamp, the probable error of the result being only ± 0·005 mgr.

NOTES

IN an overflowing Convocation at Oxford, on Tuesday, the battle of vivisection was fought out a third time. The victory of sound sense over false sentiment has again been won; and on this occasion the vote is unmistakable. In spite of the most vigorous exertions of the opponents of physiology, the decree to endow the Physiological Laboratory—as the other scientific departments in the University are endowed—has been carried by the large majority of one hundred and sixty-eight. The Dean of Christchurch opened the debate in a moderate speech recommending the grant. He pointed out that the vote was for teaching purposes, and in no way concerned vivisection, for Prof. Burdon Sanderson had given the most complete assurances that he would not use painful experiments on living animals for the purposes of teaching. Canon Liddon opposed the decree on the ground that the Council should have introduced further safeguards against the indiscriminate use of vivisection. He admitted that vivisection was justified in certain cases, and spoke of it as a painful necessity. The Bishop of Oxford denied the moral right of man to inflict pain in order to advance knowledge, and declared vivisection to be degrading to the sensibility and humanity of the operator. The vote was supported by Prof. Dicey and Sir W. Anson, and unintentionally damaged by Dr. Acland. The last speakers were much interrupted by a clamour which prevented their remarks being heard. The announcement of the result—*placets*, 412; *non-placets*, 244—was received with great enthusiasm, both in the arena and in the undergraduates' gallery. It is to be hoped that this decisive vote will put an end to the warfare waged against the teaching of physiology in Oxford.

GEOLOGISTS throughout the world will be interested to learn that Dr. Franz Ritter von Hauer, who for so many years has so admirably guided the progress of the Geological Survey of Austria, has resigned his post as Director of that institution, and has been appointed Intendant of the Imperial-Royal Natural History Museum, Vienna. He carries with him into his new sphere of labour the hearty good wishes of a large circle of friends and well-wishers, who hope that the official duties he must now perform will in no way diminish the service he has rendered to science so long and so usefully.

IT has been proposed that, for the present session, in place of the formal receptions which have hitherto been held, the rooms of the Royal Society should be kept open on certain nights in order that Fellows and their friends may meet together for conversation and for the examination of such objects of interest as may be collected for the occasion. The first of these meetings will take place on Thursday, March 19, from 7.30 p.m. Any one desirous of showing on that evening any experiments, apparatus, or specimens illustrating any inquiry in which he may be engaged, should communicate with the Assistant Secretary, in order that appropriate arrangements may be made.

THE death is announced of the eminent Russian geologist, George Helmersen, at the age of eighty-two. He studied at Dorpat under Engelhardt, whom he accompanied on his scientific journey along the course of the Lower Volga and the Ural. He subsequently took part in Hofmann's and Humboldt's explorations of the Ural region. Having completed his studies, especially in mineralogy, he spent some years, by direction of the Russian Government, in geological travels through Germany, Austria, and Switzerland. In 1835 he joined the body of mining engineers, and was appointed Director of Studies at the Mining Institute in St. Petersburg. During leisure periods he carried out a series of important geological journeys over the Kirghiz Steppe, through Norway and Sweden, the coal districts of Poland and Silesia, the mining districts of Lakes Onega and Peipus, and the bituminous coal region in the governments of Kherson and Kiev. He also thoroughly explored the gold mines at Beresovsk, and traced the course which has been followed in making the Ural Railway. The results of his indefatigable industry have been published in numerous memoirs of the Russian Academy of Sciences and other works.

WE have heard with regret of the untimely death of the eminent Russian naturalist, Mr. N. Severtsoff, which occurred on the evening of January 11, when driving across the Don, in the Government of Voronej, his horses and vehicle breaking through the ice. The coachman managed to extricate Mr. Severtsoff, but the thermometer stood at − 10° Réaumur, and, before he could be taken to a neighbouring village, he was frozen to death. It is a singular coincidence that Prof. Fedchenko, another of the greatest of Central Asian naturalists, who, like Mr. Severtsoff, had so often risked his life in the pursuit of science in Turkestan, was also frozen to death in Europe. Mr. Severtsoff so early as 1867 explored the Thian Shan as far as the sources of the Narin. His work on the vertical and horizontal distribution of Turkestan animals was written in Russian, and he has since published original researches on the birds of the Pamir. Certain portions of his remarks on Turkestan mammals and birds have been translated, and it is chiefly to him that we are indebted for what information we have in English respecting the mammals, birds, and reptiles of

Turkestan. We are glad to see, however, from Messrs. Sampson Low's catalogue the announcement of a book by Dr. Lansdell, on Russian Central Asia, in which are promised the enumeration of 4600 species of fauna and flora, in about 20 lists, with introductions to each.

PROF. SILVANUS P. THOMPSON, of University College, Bristol, has been appointed Principal and Professor of Physics at the Finsbury Technical College. The duties of Principal have hitherto been discharged by Mr. Philip Magnus, the Director and Secretary of the Institute, who temporarily undertook them pending the complete organisation of the College. As Professor of Physics at Finsbury Prof. Thompson succeeds Prof. Ayrton, F.R.S., who has now been appointed Professor of Physics at the Central Institution.

THE gift to the nation by Messrs. Osbert Salvin, F.R.S., and F. Du Cane Godman, F.R.S., of two valuable and highly instructive collections, is announced. One collection, presented on certain conditions, comprises the entire series of American birds brought together by those gentlemen, numbering upwards of 20,000 specimens, and illustrating more than any other collection in existence the life-history and geographical distribution of the birds of tropical America. No labour or expense has been spared in the formation of this splendid group of ornithological rarities. The other gift, which is unconditional, comprises a very fine collection of Central American Coleoptera of the families of *Cicindelidæ* and *Carabidæ*. It contains 969 species, and, moreover, 7678 examples, of which more than 400 are types of new species described in the work entitled "Biologia Centrali American," now in course of publication by Messrs. Salvin and Godman. To this collection will be ultimately added, by gift, the remaining families of Coleoptera, with other entomological specimens.

PROF. JEFFREY BELL has succeeded the late Mr. E. C. Rye in the editorship of the *Zoological Record*.

THE French Minister of Education has appointed a Commission, composed of astronomers and others, to report on the opportuneness of extending the decimal system to astronomical distances and time.

M. WOLF having received a sum of money from M. Worms, of Romilly, for the purpose, will begin at the Observatory of Paris a series of experiments for redetermining the velocity of light.

A COMMITTEE has been formed for organising the celebration of the centenary of the birth of Arago, who was born in Perpignan on March 17, 1786. The younger brother of Arago, M. Etienne, is director of the Luxembourg Museum.

MR. H. L. BIXBY, of Chelsea, Vt., U.S., is taking steps, *Science* states, to introduce a system of weather warnings throughout his State by means of blasts from factory whistles. The signals are as follows: after the first long, unbroken blast, usually given at about 7 a.m., a single five-second blast indicates fair or probably fair weather for the day; two blasts, foul weather; three, fair, changing to foul; four, foul, changing to fair; five, doubtful or irregularly variable. After any of these, five short blasts signify a cold wave or unseasonable frosts. The managers of the *Free Press* at Burlington undertake to send the necessary telegrams on payment of a small fee. Randolph is the first town to adopt the system: the signals are regularly given there now from a 10-inch steam-whistle.

AN experiment is being tried in the Jefferson physical laboratory, we learn from *Science*, which promises to be successful. An ordinary seconds clock, with a wooden pendulum, is controlled by the signals from the Harvard College Observatory, with no other mechanism than a fine spring connecting the pendulum to the armature of a telegraph instrument in the circuit. If the signals are interrupted during the day or night, the error of the clock, which seldom exceeds half a second in that time, will generally be rectified within an hour of their recurrence. The rate is in no way affected by the irregular signals caused in storms by the interference of the wires, and the regular impulses conveyed at intervals of two seconds increase but slightly the swing of the pendulum. The attachment can easily be made to any seconds clock at the cost of a few dollars, and may be of interest to those intolerant of the rates charged by companies for the use of electric dials.

FROM an article in the *Boston Journal* of February 7 we see that preparations are being made in the United States to observe the partial eclipse which will be visible there on March 16. Nearly 11/12ths of the sun's surface will be obscured at Washington, Baltimore, Philadelphia, New York, Boston, and Portland.

THE University of Glasgow having accepted the resignation of Dr. Bayley Balfour, the Chair of Botany in that University is now vacant. The patronage belongs to the Crown.

A PARLIAMENTARY paper published during the week (Corea, No. 1) contains, besides the trade report for Corea in the usual form, the account of a journey made by the Consul-General of Great Britain in the Peninsula. As for trade, the reports may be summed up much like the chapter on the snakes of Ireland: there is no trade, and there is no probability of there being any. The journey was from Seoul, the capital, to Songdo, to the north-east, the ancient capital of one of the three kingdoms into which Corea was divided. Some interesting information is given with regard to the production of the famous drug ginseng, so prized as a tonic by the Chinese. It is grown from a seed which is sown in March. The seedlings are planted out in beds raised a foot above the level of the surrounding soil, bordered with upright slates, and covered in from sun and rain by sheds of reeds, well closed in except towards the north side, where they are left to open. In the first or second year the ginseng plant is only two or three inches high, and has only two leaves. It is transplanted frequently during this period. In the fourth year the stem is about six inches high, with four horizontal leaves standing out from it at right angles, and in the fifth year a strong healthy plant has reached maturity, though it is more usual not to take it up until it has reached the sixth season. Ordinary ginseng is prepared by simply drying the root in the sun, or over a charcoal fire. To make red or clarified ginseng, the root is placed in wicker baskets, which are put in a large earthenware vessel with a closely-fitting cover, and pierced as the bottom with holes. It is then placed over boiling water and steamed for about four hours. Ginseng was for centuries regarded as a very elixir of life all over the East; and especially in China and Japan. Its properties were supposed to be miraculous, but they were generally supposed to be confined to the Corean ginseng. But its enormous price put it out of the reach of the poorer classes. The wild ginseng of Corea has frequently fetched twenty times its weight in silver in China. The export from Corea is a strict monopoly, which affords a considerable revenue, and is said to be the king's personal perquisite. Death is the punishment for smuggling it out of the country. The total export is only about 27,000 pounds avoirdupois.

ON February 8 died, near Hamburg, Johann Cæsar Godeffroy, until lately head of the great German firm of traders to the South Sea Islands. He was, however, much more than a merchant. Besides captains and supercargoes, he sent to Micronesia, Melanesia, Polynesia, and especially to Samoa, men of science, whose duty it was to make collections and send them to

Hamburg, to form there an exhaustive museum of natural history. The first whom he sent out on a mission of this kind was Dr. Graefe, of Zurich, now inspector of the zoological station at Trieste, who went to Samoa in 1861, and from this as a centre visited the Fiji, Tonga, and other groups in the region. He returned to Europe after eleven years, bringing with him important collections, and he undertook the editorship of a "Journal of the Godeffroy Museum." Amongst others thus despatched to the South Seas was a lady who spent ten years studying the botany of Northern Queensland, and a Polish surgeon, who lived for five years in the Marshall and Caroline Islands, then returned to Europe; returning again to the Carolines, where he is at present. A list of the men employed by Herr Godeffroy to travel in the South Seas to study the various islands, make collections for his museum, and report to him would embrace all nationalities, all departments of study, and every portion of the Southern Pacific. Eight catalogues of the Museum were published between 1864 and 1881, several of them containing zoological and geographical monographs as well. The *Journal*, which commenced in 1871, contained not only papers on the Museum and its contents, but was open to the discussion of any scientific subject connected with the South Sea Islands. Its most important feature was formed by the papers by specialists on sections of the collections sent home for the Museum. Fourteen parts were published in all, the most remarkable being on the fishes, which contained 140 plates and 312 illustrations. Through financial reverses this princely merchant died poor, and no purchaser was found for his museum, which will probably be broken up.

ACCORDING to a writer in the *North China Herald* on Chinese worship, it is certain that a great amount of fetichism prevails in that country. Near Peking, a few miles from the walls, on the east, is an enormous tree which fell more than two centuries ago, and which has been there ever since. It is called the Divine tree, and a temple has been erected for its worship. The people believe that a spirit lives in or near the tree, and should be worshipped from motives of prudence. The immense size of the tree is the result of the spirit's energy. It is believed it could not have grown so large without a present divinity. At Hantan, five or six days south from Peking, there are some iron bars in a well. In times of drought they are taken all the way to Peking to be prayed to for rain. They are placed in one temple after another, and prayers are offered to them till the showers fall. The bars are then reverently escorted back to Hantan, and placed in the well till they are again needed. In such a case the Chinese believe that there is a powerful spirit or genius in the well and in the bars, and that this spirit accompanies the bars to Peking and back again. This is Chinese contemporary fetichism, but in the ancient books there is no trace of fetichism. The objects of worship were either individual spirits or parts of nature. The ruling powers of the universe, from the highest to the lowest, were divided into four great classes—God, the subordinate heavenly powers, the higher earthly powers, and the numberless spirits that people earth and air. The subordinate heavenly powers were the seasons, the sun, moon, stars, cold and heat, floods and drought. The earthly powers were the gods of the mountains and rivers, and the last named are the spirits still remaining. Nothing is said of human spirits, though these were worshipped, then, as now, in the ancestral temples. But the worship in this instance consisted only of kneeling, prayer, and offerings.

DURING the late Health Exhibition at South Kensington the building and grounds were overrun with rats, food being plentiful and access to it comparatively easy. When the Exhibition closed, however, this ample source of provisions ceased to exist, and starvation seized upon the hosts of rodents who had for six months increased and multiplied upon the fat of the land. For a long time they were to be observed scampering here and there for food with abnormal temerity, often fighting fiercely over fragments of refuse, which evidenced their extreme voracity; and the officials on duty in the building have stated that the rats abounded in such large numbers that the noise of their movements resembled the "sound of wind." By degrees, however, they disappeared, some dying of starvation, whilst the majority emigrated to the houses in the neighbourhood; and at the present time there is scarcely one in the building.

IN connection with the Italian occupation of Massowah, materials for a meteorological station are being sent to that place.

IN the report of the Berlin Physiological Society for February 26 (NATURE, vol. xxxi. p. 404) the name of Dr. Kossel appears as Dr. Rossel.

IN the corrections in Sir William Thomson's Baltimore lecture given in last week's NATURE (p. 407), that for p. 296 should be π and π instead of $\bar{\omega}$ and $\bar{\omega}$. Sir William Thomson also asks us to state that in his Bangor address (p. 410, 2nd col. line 12 from bottom) he has inadvertently given the date of his coming to Glasgow as 1845 instead of 1846.

THE additions to the Zoological Society's Gardens during the past week include a Dwarf Common Ass (*Equus asinus* ♂) from Tripoli, presented by Mr. J. Skelding; a Bonnet Monkey (*Macacus sinicus* ♂), a Macaque Monkey (*Macacus cynomolgus* ♀) from India, presented by Mrs. M. Strachan Carnegie; an Alexandrine Parrakeet (*Palæornis alexandri* ♂) from India, presented by Mrs. Abbott; two Common Gulls (*Larus canus*), two Black-headed Gulls (*Larus ridibundus*), British, presented by Mr. F. S. Mosely, F.Z.S.; a Roan Kangaroo (*Macropus erubescens* ♀) from South Australia, three Coal Tits (*Parus ater*), British, purchased.

OUR ASTRONOMICAL COLUMN

VARIABLE STARS.—Prof. Schönfeld, in the notes to his second catalogue of variable stars, which was published in 1875, refers to the singular circumstance that R Serpentis had not been observed at its minimum, though he doubted if it descended below the twelfth magnitude. Considering that the variability of this star was detected by Harding in 1826, the want of satisfactory determinations of the times of minima might hardly have been expected; it does not appear that our knowledge in this direction has advanced during the last ten years. Schönfeld's formula assigns for dates of maxima January 27, 1885, and January 19, 1886; the middle date is July 25, somewhere about which we may look for a minimum, though it is to be remarked that the increase of light has been observed to be more rapid than the decrease, especially near maximum. Observations made during the approaching summer, and continued as long as practicable, may perhaps lead to a well-determined minimum being put on record. The position of R Serpentis for the commencement of the present year is in right ascension 15h. 45m. 23·6s., declination $+15° 29' 3''$.

A star in R.A. 14h. 8m. 0s., decl. $-11° 15'·2$ for 1885·0 is probably variable from at least 7·5m. to 10m. On April 18, 1854, it was estimated a tenth magnitude, at a subsequent date 8·5, and on March 18, 1874, it was as bright as 7·5. It is not in Lalande, Bessel, Santini, Lamont, nor in the Bonn Observations, vol. vi. It is entered on Harding's Atlas as a seventh magnitude.

THE OCCULTATION OF ALDEBARAN ON MARCH 21.—The disappearance of Aldebaran at its next occultation by the moon takes place while the star is yet above the horizon at Greenwich, but its altitude there will be less than $2\frac{1}{2}°$. At Exeter the star disappears at 11h. 45m. 19s., Greenwich time, at an altitude of $4\frac{1}{2}°$, so that there is a possibility of observations in the west of England.

THE NAVAL OBSERVATORY, WASHINGTON.—In accordance with an intention notified several months since, Commodore

Franklin, U.S.N., Superintendent of the Observatory at Washington, issued a programme of work which it was proposed to undertake in that establishment during the present year. With the great equatorial, measures of a selected list of double stars, showing rapid motion or other peculiarity, are to be continued; the conjunctions of the inner satellites of Saturn will be observed, and a complete micrometrical measurement of the rings executed; observations which have been commenced for stellar parallax will be finished. The Transit Circle is to be employed on observations of the sun, moon, and larger planets, the latter being observed from fifteen to twenty times near opposition, and in addition each minor planet will be observed at least five times, if practicable, near opposition. The 9·6-inch equatorial will be utilised for observations of all the minor planets whose brightness at opposition is greater than their mean brightness, for positions of comets, and for occultations. The prime-vertical transit instrument is to be used in observing a selected list of stars, in conjunction with the Royal Observatory at Lisbon, in pursuance of a plan recommended by the International Geodetic Association, for the determination of variability of latitude. With the mural circle observations will be made of stars down to the seventh magnitude, south of 10° north declination, the positions of which have not been recently determined at any northern observatory, the observatory list including stars in Gould's *Uranometria Argentina* not found in Yarnall's catalogue, the transit circle list of B.A.C. stars, or the recent catalogue of the Glasgow Observatory. These principal items in the programme prove that it is not intended that the Naval Observatory shall fall short of its usual activity during the year 1885.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *MARCH* 15–21

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 15

Sun rises, 6h. 16m.; souths, 12h. 8m. 58·1s.; sets, 18h. 3m.; decl. on meridian, 1° 57′ S.: Sidereal Time at Sunset, 5h. 37m.

Moon (New on March 16) rises, 5h. 34m.; souths, 11h. 9m.; sets, 16h. 52m.; decl. on meridian, 5° 51′ S.

Planet	Rises	Souths	Sets	Decl. on Meridian
	h. m.	h. m.	h. m.	° ′
Mercury	6 25	12 17	18 9	2 29 S.
Venus	6 2	11 23	16 45	8 17 S.
Mars	6 10	11 45	17 20	5 34 S.
Jupiter	15 14	22 27	5 40*	13 24 N.
Saturn	9 30	17 34	1 38*	21 44 N.

* Indicates that the setting is that of the following day.

Occultations of Stars by the Moon

March	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
18	B.A.C. 481	6½	18 58	19 54	153 314
21	B.A.C. 1351	6½	18 30	18 58	193 242
21	75 Tauri	6	20 37	21 34	111 336
21	B.A.C. 1391	5	22 0	near approach	43 —
21	Aldebaran	1	23 43	0 32†	128 305

† Occurs on the following day; is below horizon at Greenwich.

Phenomena of Jupiter's Satellites

March	h. m.		March	h. m.	
15	1 21	II. occ. disap.	20	2 12	I. occ. disap.
	5 22	II. ecl. reap.		5 9	I. ecl. reap.
	18 31	I. tr. egr.		22 24	III. tr. ing.
16	19 28	II. tr. ing.		23 31	I. tr. ing.
	22 24	II. tr. egr.	21	1 51	I. tr. egr.
18	18 40	II. ecl. reap.		2 2	III. tr. egr.
19	5 4	I. tr. ing.		20 38	I. occ. disap.
				23 37	I. ecl. reap.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

March	h.	
15	19	Venus in conjunction with and 3° 32′ south of the Moon.
16	6	Mars in conjunction with and 2° 32′ south of the Moon.
16		Annular eclipse of Sun; not visible in England. In Ireland the commencement of the eclipse may be seen, the sun setting very shortly afterwards.
17	1	Mercury in conjunction with and 1° 37′ south of the Moon.
20	..	Sun in equator.

GEOGRAPHICAL NOTES

The Australian journals which have arrived by the last mail contain full reports of the four days' conference of the Geographical Society of Australasia at Melbourne. Gen. Sir Edward Strickland was elected President, and Baron F. von Müller, Vice-President. The first resolution proposed that the term "Australasia" should be strictly defined. The expression was first used by Mr. Wallace, but it appears to have already had various inconsistent meanings applied to it. The proposer suggested that the following definition would serve all purposes: Australasia is that part of Oceania of which Australia is the geographical, commercial, and political centre. Limits: on the west and part of the north the 100° of longitude; east, to the point of its intersection with the 20° south latitude, thence by a line running in approximate parallelism to the western and northern coast of New Guinea, and around its north-western extremity to the equator; thence on the north, by the equator, to its intersection with the 120° of longitude west, and on the east by the 120° to the south pole, including groups of islands on the equatorial line. The question was ultimately referred to a strong committee. The next resolution affirmed the desirability of a scientific exploration of New Guinea under the auspices of the Society. A corollary calling on the Government to define the boundaries of the British possessions in that island was rejected in favour of one for complete annexation. The compilation of standard works on the geography of Australasia, as well as of school maps, was also discussed. After much discussion it was decided that the consideration of the aptest means for discovery of the fate of Leichhardt and his party should be left to the Colonial Councils of the Society, with a suggestion that a circular should be addressed to pastoral tenants in Western Queensland and Central Australia, requesting information on the subject. The formation of geographical societies, and their affiliation with the central body, in South Australia, Queensland, Western Australia, New Zealand, and Tasmania was also recommended. The next Conference will meet at Sydney.

At the meeting of the Geographical Society of Paris on February 20 a communication was read from Dr. Gustave Le Bon, the author of a work on Arab civilisation, who is at present travelling in Nepaul. For the purpose of measuring the ancient monuments of various native states he has employed certain new instruments, which he will explain to the Society on his return a few months hence. Nepaul is closed to Europeans, and Dr. Le Bon is said to have been the first who has been permitted to travel through it.—M. de Lavigne spoke on the French law protecting cartographers from piracy, which he held to be ample. A method of discovering counterfeits, adopted by certain French cartographers, is said to be the insertion of some street, town, or place with an imaginary name.—M. Pinart described a journey which he made in Chiriqui, in Panama, to study the manners, language, and monuments of the inhabitants.—M. Potel discussed the present situation of French trade in the River Plate.

From *Science* we learn that several expeditions to Alaska are projected during the coming season. Gen. Miles, commanding the military district of which the territory forms a part, desires to acquire a knowledge of the unexplored region between the head of Cook's Inlet and the Tananah watershed. The course of the Tananah is likewise unmapped, except from hearsay, though often traversed by traders in the last fifteen years; so that the opportunity exists here for a fruitful expedition. It is hoped that arrangements may be practicable by which Lieut. Ray, well known for his successful direction of the Point-Barrow party, may be able to command such an exploration. The plan contemplates work either from the Yukon as a base, with a steam-launch and a small party, ascending in June and July, and returning before navigation closes, or an expedition by way of Cook's Inlet, making the portage to the Tananah, and then descending; but a final decision is not yet reached. The party under Lieut. Abercrombie did not succeed in obtaining native assistance,

as expected, and were unable to pass beyond the glacier alleged to obstruct the Copper or Atna River, about sixty miles from the sea. Meanwhile, a party has actually started, under Gen. Miles's orders, January 30, for the Copper River, consisting of Sergeant Robinson and F. W. Ficket, signal-observer U.S.A., and commanded by Lieut. Allen. They intend to go to the mouth of the Atna or Copper River by steamer, and ascend as far as possible on the ice, pushing on by water as soon as the ice breaks up and the freshets are over. They hope to cross the divide from the Upper Atna, and descend by one of the Yukon tributaries to the mouth of the latter river, and rejoin civilisation at St. Michael's. They may be fortunate enough to make the journey in one season, but are prepared to stay two years. They will add a number of Indians to the party at Sitka, and carry various peace-offerings for the Atna Indians. Lieut. Stoney, of the navy, is reported to have a new expedition nearly organised to continue his investigations of the Kowak River. The plan adopted, so far as yet decided upon, is to take a steam-launch, ascend the river as far as possible, and pursue the explorations to its source, and winter in the region if necessary. It is stated that the party is to be composed of sixteen men, which is dangerously large, considering the limited food-resources of the region, and might be advantageously diminished by one-half for explorations in the interior. If the party were to pass over the divide, and investigate the course of the Colville, returning *viâ* Point Barrow next summer, it would accomplish a praiseworthy and much-needed investigation.

We have received from Messrs. W. and A. K. Johnston a school physical wall map of England and Wales, in which the altitudes above sea-level are shown by varieties of tint. Of its kind this map is good, though we should prefer to see the method of tints combined with the graphic method, in order that pupils may be taught to read the maps with which they have to deal when they become men and women. Accompanying the map is a little hand-book of the physical geography of England and Wales.

THE SCOPE AND METHOD OF PETROGRAPHY[1]

In considering the history of geology we are struck by the fact that towards the close of the last and during the commencement of the present century, when the science was taking rank as an important branch of human knowledge, petrography occupied a much higher position than it has at any subsequent period.

Werner, whose influence was almost unrivalled at the time to which I have referred, was a mineralogist, and his formations were therefore naturally based on the mineralogical characters of the different rocks. His observations were limited for the most part to his own district of Saxony, but he regarded his formations as sediments or precipitates from a universal ocean, and his numerous pupils, fired by his love of science and his intense enthusiasm, rejoiced in extending his classification to the districts with which they were severally acquainted.

The magnificent work of those who devoted special attention to the organic remains in the sedimentary deposits, and especially that of William Smith, the "Father of British Geology," had the effect of deposing petrography from the position which it held under the influence of Werner and his followers. It was clearly shown that the fossil contents of the strata were far more reliable as evidence of chronological relations than their lithological characters, and as soon as this became generally recognised, the reduction of the fossil-bearing rocks all over the world to something like definite order followed as a natural consequence.

The principle that strata may be identified by means of their fossil contents has not only proved applicable to the Secondary and Tertiary formations to which it was originally applied by Smith, Cuvier, and others, but it has been extended by Murchison, Sedgwick, Barrande, and others to the older rocks. Speaking broadly, there can be no doubt that over large areas the succession of the forms of marine life has been remarkably uniform from the Cambrian times down to the present, so that we have in the fossil contents of the different strata by far the most reliable means of determining chronological relations.

It is not surprising, then, that petrography has been comparatively neglected by geologists, for their main object during the present century has been to classify the stratified rocks which form so large a portion of the existing land surfaces.

At the present time, however, we are witnessing a great revival of interest in petrography, not only in this country but all over the globe. This is due in part, no doubt, to the introduction of new methods of research; but it seems to me that there are other and more general causes. The clear recognition of the great principle with which the name of William Smith is so indissolubly united at once made it possible for a host of observers to do excellent work in every quarter of the globe. The interest awakened by the study of the geological structure of the most densely populated regions was akin to that which is felt by the geographical explorer of unknown lands. Until the main features of the geology of fossiliferous regions were described, it was not to be expected that observers would turn aside from a field of research in which they were certain to meet with success for the purpose of attacking problems which, after all, might prove to be insoluble. As time went on, the unexplored tracts in which fossiliferous rocks occur became more and more restricted, or more and more inaccessible, and when the old chaos of Grauwacke fell into order before the brilliant researches of Sedgwick, Murchison, and Barrande, geologists were placed in an entirely new position. They had conquered that portion of the world which was open to their special method of attack. A number of fortresses still held out, it is true, and many of these remain unsubdued at the present day. They will doubtless occupy the attention of those who are most skilled in the old methods of warfare for many years to come. At the same time I think it will be admitted on all hands that the brilliant successes of the old generals have left a large portion of the army with little to do. We must, therefore, look for other worlds to conquer.

Now, on taking a general survey of the subject-matter of geology it will be seen at once that we are profoundly ignorant on questions relating to the origin and sequence of volcanic rocks, the cause or causes of volcanic action, the mode of formation of the crystalline schists, and the origin of mountains. That these questions are really unsolved is proved by the difference of opinion which exists between competent observers. Another point which strikes one is, that if a solution of these problems be ever realised, it will be due in a great measure to the combination of field geology and petrography. This, it seems to me, will explain the great interest which is taken in the latter branch of science at the present day. If I am right in my opinion as to the present state of things, then we may safely predict that petrography will occupy as prominent a position in the immediate future of geology as palæontology has done in the past. In making this statement I trust it will not be thought that I am claiming too high a position for that branch of geology with which I am most intimately acquainted.

Let us turn now to a more detailed consideration of the scope and method of petrography. The rocks of the earth's crust form the subject-matter of the science. Now these may be studied from two more or less distinct points of view—the descriptive and the ætiological. We may set to work to describe the rocks, that is, to ascertain and record every possible fact with regard to them; or we may endeavour to trace the succession of events which has culminated in the state of things which we actually observe. It is perfectly obvious that we cannot hope to attain any considerable success in the second branch of the subject until we have devoted a considerable amount of attention to the first.

Descriptive petrography then concerns itself with the chemical, mineralogical and physical characters of the individual rocks, and also with the distribution and mutual relations of the different varieties. The last-mentioned branch of the subject occupies the same position in petrography as comparative anatomy does in zoology. It may therefore be termed comparative petrography.

When the history of the science comes to be written, it will be recognised that it is to the Germans we are especially indebted for our knowledge of descriptive petrography. The amount of work which has been done in Germany is immeasurably greater than that produced by other nations. For years past they have been steadily improving their methods of observation, as well as observing and recording facts. Moreover, they have been training petrographers who are now scattered all over the world. The Americans especially have availed themselves of the laboratories of Rosenbusch and Zirkel, and almost every Annual Report of the American Survey now bears witness to the influence of

[1] Lecture delivered in the Woodwardian Museum, Cambridge, by J. J. H. Teale, M.A., F.G.S.

Germany from a teaching point of view on the growth of petrographical science. In this sketch, of course, I am only calling attention to the broad facts of history as far as regards the special branch of descriptive petrography. Many observers in France, England, and America have done independent work of the very highest order, and to England especially belongs the credit of having, in the person of Sorby, determined to a very large extent the introduction of the modern methods of microscopical research.

Consider now what is involved in the description of any particular rock, and take, for example, a specimen of the Whin Sill, that mass of basic igneous rock which plays such an important part in the Carboniferous region of the North of England.

The rock is dark gray or bluish-gray when freshly exposed. In texture it varies from compact to coarsely crystalline, the most common variety being one in which the individual constituents are just recognisable by the naked eye. Its specific gravity varies from 2·90 to 2·95. Its chemical composition is shown on this table. (Table referred to.) We have now to consider its mineralogical composition. In the determination of minerals in rocks we use physical and chemical methods. Colour, general appearance, hardness, cleavages, specific gravity, crystalline form, fusibility, and flame coloration are some of the most important physical properties available for the determination of minerals in rocks when they can be examined macroscopically. In thin sections we can use colour, general appearance, cleavages, form, and also the many properties which are brought out by the use of parallel and convergent rays of polarised light. Chemical tests may be applied both to macroscopically recognisable minerals and also to those which can only be observed by the use of thin sections or minute particles and the microscope. The latter are generally referred to as microchemical tests.

By applying these methods, some of which will be more fully explained in the subsequent lectures, we can prove that the rock of the Whin Sill is composed of felspar, pyroxene, titaniferous magnetic iron ore, quartz in the form of grains and also as a constituent of micro-pegmatite, apatite, pyrite, brown hornblende, mica, and some green decomposition products. Apatite, pyrite, hornblende, and mica occur only in very small quantity, and cannot be said to form any appreciable portion of the rock.

In order to give a complete petrographical description, however, it is necessary that we should not only know what minerals are present, but also that we should know the precise composition of each and the relative abundance of the different species. Information on these points can only be obtained by isolating the different constituents of a rock and analysing them separately. Methods of isolation will be described in subsequent lectures. The most important are those which depend on the use of heavy solutions, the magnet and electro-magnet, and various chemical reagents, especially hydrochloric and hydrofluoric acids. The chemical composition of each of the three principal constituents of the Whin Sill is represented on these tables. (Tables referred to.) Now, having obtained a knowledge of the composition of the principal constituents of the rock, it becomes possible to determine with a very fair amount of accuracy the relative proportions of these constituents by calculations based on the bulk analysis of the rock.

There is yet another point of great importance to which attention should be paid in subjecting a rock to an exhaustive examination. Owing to the brilliant researches of Sandberger, it is beginning to be recognised that many of the heavy and so-called rare metals are present in ordinary rocks in minute quantities. Until recently we have been disposed to regard these substances as occurring only in mineral veins and in the deeper portions of the earth from which the mineral veins have been supposed to derive their supply of material. Now it is beginning to be clearly recognised that these substances are very widely distributed even in the superficial crust of the globe. As an illustration of the interest and practical importance of the subject above referred to I may call attention to the important work by Dr. Becker, on the "Geology of the Comstock Lode," recently published by the U.S. Geological Survey. This lode, the yield of which is supposed to have sensibly affected the bullion markets of the world, occurs in a region which is remarkable for the extreme development of igneous rocks (diabase, diorite, andesites, &c.), and for the widespread alteration to which these rocks have been subjected. The bisilicates, especially, have been affected by this alteration, and for immense distances they have been entirely replaced by a green chloritic mineral.

Most careful assays have been executed, under the supervision of Dr. Becker, for the purpose of determining the amount of bullion in the fresh and unaltered rocks, and the relative amounts of gold and silver. He says: "By comparison of the different assays it appears that decomposed diabase carries somewhat less than half as much silver as the fresh rock. When the decomposed rocks are pyritous, the experiments made do not indicate any essential diminution of the gold contents. This fact, however, is quite possibly due to irregularity in distribution and the minuteness of the quantities of gold to be determined. As the decomposition of the rock in question has proceeded at a great depth beneath the surface, it is highly unlikely that silver should have been extracted unaccompanied by gold. Much of the decomposed rock, too, is nearly free from pyrite, and had the gold contents of such specimens been determined, a smaller percentage would probably have been found. The omission [to select specimens free from pyrite] was not detected until it was too late to resume the investigation. So far as quantitative relations are concerned, the silver only can be relied on, though the qualitative detection of gold as well is both interesting and important."

Another point of great interest was determined by Dr. Becker. He isolated the felspar and the augite of the diabase and tested both from silver. He found that for equal weights the augite was eight times as rich as the felspar substance, and as the latter contained some augite, this appears to furnish substantial proo that the silver is a constituent of the augite.

Having subjected a rock to exhaustive chemical and mineralogical examination, it next becomes necessary to compare it with other rocks, and to give it a name. The subject of nomenclature is a very difficult one. It is much to be regretted that notwithstanding all that has been done in descriptive and comparative petrography, we are still far from having any system of classification which is capable of general acceptance. Indeed, we are not agreed as to the first principles on which a classification of rocks should be based. The German petrographers, in most cases, adopt at the outset a principle which we cannot accept. They divide igneous rocks into older and younger: the former including all those which they regard as pre-Tertiary, the latter all those which are of post-Cretaceous age. The division is based, of course, on the assumption that the conditions of eruption in pre-Tertiary times were essentially different from those which have prevailed since. There seems, so far as we can judge, little or no ground for this assumption. The few facts which do at first sight lend support to it appear to be equally capable of explanation on the other hypothesis. The typical pre-Tertiary rocks of the German system are the granites, diorites, gabbros, diabases, and syenites. Now there is reason to believe that these are all plutonic rocks; in other words, that they are the result of slow consolidation beneath the surface, and therefore under great pressure. If this view be correct then their exposure at the surface can only occur long after their formation, and the fact that the majority of those known to us should be of pre-Tertiary age, as Lyell long ago pointed out, need occasion no surprise.

Again, it must be remembered that the mere association of eruptive rocks with pre-Tertiary deposits is no proof in itself that the former are of pre-Tertiary age, and also that many competent observers believe that these are clear cases of Tertiary granite, diorite, diabase, and gabbro.

The igneous rocks, which are regarded by the German petrographers as especially characteristic of the post-Cretaceous period, are the basalts, andesites, trachytes, and rhyolites; in other words, the surface-products of volcanic action. That these should be mainly Tertiary, and that they should differ to a certain extent from their pre-Tertiary equivalents in consequence of alteration, is only what might be naturally expected. This, however, is not sufficient to justify the refusal to give the same name to different specimens of one and the same rock merely because they have been produced at different periods; and the work of Allport, Bonney, Geikie, and others has proved that there are basalts, andesites, and rhyolites of Palæozoic age which are identical in structure, composition, and mode of occurrence with modern rocks.

In the absence of any generally recognised system of nomenclature it becomes difficult to assign a name to the rock of the Whin Sill. It is a holo-crystalline rock composed essentially of plagioclase, pyroxene, titaniferous and magnetic iron ore. In sections the felspar occurs in lath-shaped forms. To such a rock, provided it be of pre-Tertiary age, Rosenbusch would

give the name diabase. We are inclined, on the other hand, to call the rock a dolerite. The important point for the student to remember, however, is that in the present unsettled state of nomenclature his primary duty is to make himself familiar with the structure and composition of the various rock types. The question of names is, after all, only of secondary importance, provided we remember that in looking at the facts through the medium of an unphilosophical nomenclature we may so distort them as to fail to realise their true forms and relations.

Consider now the ætiological aspect of petrography. Most of us are so constituted that we cannot rest satisfied with a mere description of facts; we almost instinctively endeavour to discover what we call the origin of things. This, after all, merely consists in tracing back as far as possible the chain of events of which the object or phenomenon in question represents the last link. The search after causal relations in the organic world has led to the introduction of a principle which is now recognised as one of the greatest importance in almost every branch of human knowledge. Changes in the characters of organisms are now admitted to be determined by two factors—the inherent properties of the organism and the influence of surrounding circumstances. A very little consideration will serve to show that the changes which occur during and subsequent to the development of minerals and rocks are determined by two allied factors.

Take the case of crystallogenesis. It is not difficult to see in a general kind of way that the characters which a crystal possesses have been determined (1) by the inherent properties of the crystallising substance, and (2) by the influence of surrounding circumstances—of the environment. When we examine thin sections of rocks, furnace-slags, or the refuse products of glass-works, we frequently find a number of bodies which are intermediate as it were between glass and true crystals. These have been carefully examined and admirably described by Hermann Vogelsang, who has also succeeded in producing many of them by artificial means. As they serve to illustrate in a very striking way the principle above referred to, a short description of Vogelsang's experiments will not be out of place.

The crystallising substance finally selected by Vogelsang for the purpose of his experiments was sulphur. This substance is readily soluble in bisulphide of carbon, out of which it crystallises in the rhombic form. If the process of crystallisation be followed under the microscope, nothing definite as to the nature of crystalline growth can be made out. The first objects which appear are definite crystals, and these grow by accretion. If, however, the solution of sulphur be thickened with Canada balsam then, provided the proper proportions of the different substances have been employed, some very interesting phenomena may be observed by the aid of the microscope as the bisulphide of carbon evaporates. Minute fluid spheres arise in the medium and grow by mutual absorption. They finally consolidate as clear, transparent, isotropic bodies, and to them Vogelsang has applied the term globulites. It is impossible to determine absolutely the composition of these globulites, but there seems no reason to doubt the conclusion of Vogelsang that they are portions of the Canada balsam which are richer in sulphur than the surrounding mass, and that they arise in consequence of the attempt of sulphur to crystallise under unfavourable circumstances. Similar bodies may be observed in certain rocks, slags, and blow-pipe beads, although the crystallising compounds must be very different in the different cases.

Under certain circumstances the mass of sulphur and Canada balsam solidifies with the formation of globulites, but under other circumstances additional phenomena may be observed. When the resistance of the medium is too great to prevent the union of the globulites, but not too great to prevent their approach, they become united into various more or less definite forms. The mode of union depends partly on the way in which the globulites attract each other, and partly on the movements in the mass. A linear arrangement of the globulites is very common, and to the form arising in this way Vogelsang has given the name margarite. A rectangular grouping is also not uncommon. From a study of the various forms arising in consequence of the union of globulites, Vogelsang concludes that in the case of sulphur there are in each globulite, as it were, three directions at right angles to each other, in which the attraction is considerable, and that in one of these the attraction is decidedly greater than in the other two.

The building up of the compound forms naturally leaves the surrounding space free from globulites.

Under certain circumstances the globulites become fused, as it were, at the points of contact. This occurs when the resistance is sufficient to prevent the assumption of the spherical form, but not sufficient to resist the destruction of the pellicle at the point of contact. In this way rod-like bodies, termed longulites, arise.

It must be remembered that all these forms are strictly isotropic. They are not, therefore, in any sense of the word, crystals. The moment a true crystal of sulphur appears, it can be recognised by its doubly-refracting properties. They have been termed crystallites, wherever they occur, by Vogelsang, and they evidently arise in consequence of the attempts of some definite chemical compound to crystallise under conditions which do not admit of the free approach of the molecules.

Between crystallites and perfect crystals showing definite external faces there are numerous intermediate forms, such as microlites and skeleton crystals. As further illustrations of the influence of the environment we have only to consider the facts that no two crystals of the same substance are precisely alike in all their characters, and that some substances, like sulphur and carbonate of lime, may be made to crystallise in two different systems by varying the conditions under which the crystallisation is effected.

There can be no doubt, then, that two factors are involved in the determination of the properties which crystals present: the inherent forces of the crystallising substance and the influence of surrounding substances.

So far we have referred only to the birth and growth of crystals. But the history of a crystal does not cease with its formation. With a change in the surrounding circumstances the crystal may be modified or destroyed. Thus we see that crystals have a kind of life-history: they are born, they grow in size by accretion, and finally they cease to exist as distinct individuals.

As an illustration of the influence of a change of physical condition on the character of a crystal, consider the case of leucite. At ordinary temperatures this mineral is generally regarded as tetragonal, and it certainly shows double refraction in thin sections. Klein has shown that by heating leucite to a point far short of its fusibility it may be rendered perfectly isotropic, and hence follows the conclusion that leucite is really isotropic when subject to the conditions under which it is formed. That crystals should be in a state of stable equilibrium, so far as molecular forces are concerned, when subject to the physical conditions under which they are formed, is exactly what we should expect, and that this equilibrium may be disturbed by a change in these conditions is also very easy to understand.

As further illustrations of the principle here referred to, consider the various cases of paramorphosis, such as the change from arragonite to calcite, or from calcite to arragonite; or, again, the corresponding changes in sulphur.

Illustrations of the changes which arise in crystals in consequence of changes in the chemical conditions to which they are subjected, need not here be referred to in detail; the destruction of crystalline rocks by denudation is of course a consequence of these changes.

Consider, now, the rocks of which the earth's crust is composed. They also have a life-history. They are formed and destroyed, and it is the business of the petrographer not only to describe and classify them, but also to trace out the cycle of change. For the purpose of illustrating this branch of petrography let us consider certain facts with reference to the genesis of crystalline igneous rocks. It will be admitted on all hands that such rocks as granite, syenite, diabase, rhyolite, trachyte, andesite, and basalt have originated by the consolidation of an intensely heated silicate-magma under different conditions as to temperature and pressure. The consolidation has been accompanied—except in those cases where the magma has consolidated as a homogeneous glass, and these will be left out of account for the present—by the development of crystals. If, then, we would understand the manner in which crystalline igneous rocks have been formed, we must consider the subject of crystallogenesis in silicate-magmas. Numberless facts which need not here be referred to prove that the process of consolidation is not a sudden one. As the surrounding circumstances (environment) become more and more favourable to crystallisation, the minerals separate out one after the other, and at last the whole mass becomes solid, and the rock is formed. The temperature at which any given mineral forms is not determined by its own fusibility. The laws of the formation of minerals in

igneous rocks are analogous to those which determine the formation of salts from concentrated aqueous solutions. Cooling influences the separation of the different minerals only in so far as it affects the solubility of the constituents of the minerals in the silicate-magma. The point at which a mineral forms from a silicate solution has, then, no more connection with its fusibility than the point at which graphite forms in molten iron has with *its* fusibility.

Another point of very great importance is this: the differentiation of crystals in an originally homogeneous magma must necessarily be accompanied by a variation in the composition of that magma. It becomes, then, of great interest to determine the general order of the formation of crystals in igneous magmas. On this subject we have a most valuable and suggestive paper by Rosenbusch, entitled "Ueber das Wesen der körnigen und porphyrischen Structur bei Massengesteinen" (*Neues Jahrbuch*, 1882, ii. p. 1). Before proceeding to give an account of the portion of this paper which bears more particularly on the subject we are now discussing, it may be well to call attention to the methods available for the purpose of determining the order of the formation of the minerals in a rock. There are two. In the first place we may observe the phenomena of inclusions, and in the second place we may observe the extent to which crystalline form has been developed. If one mineral is seen to be included in another, then we may safely infer, subject to certain precautions, that the included mineral is the earlier of the two, and if one mineral shows a more perfect form than another with which it is associated, then we may infer—again subject to certain precautions—that the mineral with the more perfect form is the earlier.

Now in the paper above referred to, Rosenbusch divides the constituents of igneous rocks into four groups:—

(1) The ores and accessory constituents (magnetite, hematite, ilmenite, apatite, zircon, spinel, sphene).

(2) The ferro-magnesian silicates (biotite, amphibole, pyroxene, olivine).

(3) The felspathic constituents (felspar, nepheline, leucite, melilite, sodalite, haüyn).

(4) Free quartz.

He then calls attention to the contrast which is presented by the granites and syenites on the one hand, and the diabases on the other. In the former the following law is adhered to with a very great amount of persistence:—The order of formation is that of increasing basicity: the ores and accessory constituents are first formed, and the quartz is the final product of consolidation. In the diabases and gabbros there is apparently an exception to this law of increasing basicity, the augite consolidating after the felspar. Rosenbusch proposes to divide the granular holo-crystalline rocks into two classes: (1) those in which the minerals of the 2nd group in the above classification consolidate before those of the 3rd, and (2) those in which the reverse relation holds. He then calls attention to cases illustrative of the law of increasing basicity which are furnished by the order of separation in the individual groups. Thus in the ferro-magnesian group, olivine is older than biotite, amphibole and pyroxene; and biotite is older than the bisilicates. In the felspathic group triclinic felspars are older than monoclinic [there are exceptions to this rule, as, for instance, in the porphyroid of Mairus in the Ardennes, where orthoclase crystals are seen to be surrounded by a narrow zone of oligoclase], and the basic triclinic felspars are older than those which contain a large percentage of silica.

The views of Rosenbusch are based on the assumption that the order of formation of crystals in igneous magmas is determined solely by chemical conditions. That these conditions are the more potent seems quite clear, but there are facts which appear to show that physical conditions are not altogether without influence on the result.

The law of increasing basicity may be accepted without hesitation as expressing in a general way the truth as regards the order of separation of the different constituents of igneous rocks.

Now a very interesting conclusion follows as a natural consequence of this law. The effect of progressive crystallisation in a magma must be to increase the percentage of silica, to decrease the amount of lime, iron, and magnesia, to increase the total amount of alkalies, and to increase the potash relatively to the soda in the part which remains liquid. It is always satisfactory to find independent evidence confirmatory of any conclusion at which one may have arrived. Now I think we have confirmatory evidence of this kind in the present case. It will be admitted on all hands that the crystals in porphyritic rocks, such as hypersthene-andesite, have been formed in a magma the composition of which is represented by the bulk analysis of the rock. If, then, we compare the bulk analysis with the analysis of the ground-mass deprived of its crystals, we ought to find confirmation of the above conclusion.

Dr. Petersen has isolated and analysed the ground-masses of two of the Cheviot porphyritic rocks, and by comparing these with the bulk analyses of the rock the truth of the conclusion is most strikingly illustrated. The effect of progressive crystallisation in the andesitic magma has led unquestionably to an increase in the amount of silica, a decrease in the amounts of lime, iron, and magnesia, an increase in the amount of alkalies generally, and an increase in the potash relatively to the soda. In the rock itself soda is in excess of potash; in the ground-mass potash is in excess of soda.

There is yet another piece of independent confirmatory evidence. Every geologist is familiar with the phenomenon of contemporaneous veins. The general view held with regard to them is that they represent portions of material which remained fluid after consolidation had progressed to a considerable extent. If this view be correct, then they should hold the same chemical relation to the main mass of the rock as the ground-mass of the Cheviot andesite does to the main mass of the andesite. Mr. Waller has recently analysed certain contemporaneous veins which occur in the bronzite-diabase of Penmænmawr. He finds that they contain about 7 per cent. more silica than the normal rock, less lime and magnesia, more alkalies, and more potash than soda, although in the normal rock soda is in excess. Contemporaneous veins in the Rowley rag dolerite have also been investigated by Mr. Waller, with the same result as far as increase in silica and total alkalies is concerned. The relation of potash to soda has not yet been determined.

I believe it is admitted to be a general rule that contemporaneous veins contain more silica than the rock with which they are associated. It will be seen that there is abundant evidence of an independent character to confirm the general truth of the conclusion which follows from a consideration of the facts brought forward by Rosenbusch.

I should not have treated this subject at such length did it not appear to have an important bearing on the origin and sequence of volcanic rocks. I can best explain this by referring to the Cheviot district, with which I am slightly acquainted.

Andesitic lavas and tuffs cover large tracts of this district. These are unquestionably the products of surface volcanic action. In the central portion of the volcanic area there is a mass of augitic granite. A consideration of the mineralogical composition of this granite shows that it cannot belong to the acid group of rocks, and this conclusion is confirmed by an examination of the chemical composition of allied rocks from the Vosges. So far as we can judge in the absence of analyses there appears to be a very close connection between the composition of the plutonic and that of the volcanic rocks of the Cheviot district, and we therefore seem justified in concluding that the plutonic masses differ in character from the andesitic lavas merely in consequence of differences in the conditions of consolidation. The plutonic rocks represent the consolidation of the andesitic magma beneath the surface, and therefore under great pressure; the lavas and tuffs represent the consolidation of the same magma at the surface.

I now come to the point to which I wish to direct special attention. The andesitic lavas and tuffs are traversed by quartz-felsite dykes in such a way as to show that a magma of rhyolitic composition must have been erupted by the Cheviot volcanoes subsequently to the period characterised by the eruption of the andesitic magma. Contemporaneous veins similar in character to the quartz-felsite dykes also occur in the plutonic rocks. Again, an analysis of one of the quartz-felsite dykes by Mr. Waller agrees almost exactly with the analyses of the ground-mass of the hypersthene-andesite by Dr. Petersen.

Putting all these facts together, we conclude that the eruption of an andesitic magma was followed, in the history of the Cheviot volcanoes, by that of a rhyolitic magma in consequence of progressive crystallisation in the deep-seated plutonic source. The rhyolitic magma is, so to speak, the mother liquor out of which various basic minerals have crystallised. Suppose a half-consolidated plutonic mass, originally of andesitic composition, to become subjected to a powerful crush such as that which unquestionably arises in the earth's crust under certain circumstances. The mother liquor will be squeezed out of the mass,

like whey out of cheese, and it may finally consolidate as contemporaneous veins in the plutonic rock, as dykes in the surrounding volcanic rocks, or as rhyolitic lavas and tuffs at the surface. The ideas here thrown out appear to me to be capable of extension to other volcanic regions; but as the sequence in these regions is generally complicated by the coming in of basic rocks during the later phases of volcanic activity, it will not be advisable to enter more fully into the subject on the present occasion.

The special characters which igneous rocks present, then, are to be traced to the chemical and physical properties of the original magma and to the influence of surrounding circumstances. Rocks, like minerals, are in a state of stable equilibrium when subjected to the conditions of their formation. When subjected to other conditions, whether physical or chemical, they usually undergo a change. The destruction and disintegration of igneous rocks by the various agents of denudation are familiar to every student of geology, and need not therefore be described on the present occasion.

I trust I have now said sufficient to show that the science of petrography is one of the greatest importance to the geologist of the present day. The remarks on ætiological petrography are, of course, only intended to illustrate the nature of this branch of the subject, and to show that conclusions of the greatest theoretical interest may be expected to follow from a careful consideration of the facts acquired by work in the other branch of the science.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—A Report recently issued gives particulars of the successful raising of the roof of the Mineralogical Museum to form a Morphological Laboratory on the new floor thus created. The firm of builders who had furnished estimates ultimately declined the work, and the Department of Mechanism undertook it. Under the continual superintendence of Prof. Stuart and Mr. Lyon the work was so skilfully done that not a crack was occasioned in the ceiling of the Mineralogical Museum, and the deflection of the new timbers was so well calculated that no timber moved upwards or downwards more than the eighth of an inch when the load came upon it. The cost was several hundred pounds less than the estimate. The roof raised was 110 feet long, and the weight fifty tons. A special vote of thanks is to be given to the Department of Mechanism for the care, skill, and economy with which the building operations were conducted.

The Botanical Laboratory has cost a little over 800*l.*; the Morphological Laboratory has cost about 2500*l.*

In the Natural Science "Special" Examinations for the ordinary B.A. degree during the past year, the great majority of candidates chose Chemistry, and showed that they had bestowed considerable pains on laboratory work while yet they were only imperfectly acquainted with the *rationale* of the processes they employed. The candidates in Botany had neglected systematic, and especially descriptive, botany. In June the descriptions of easy, well-marked specimens of flowering-plants were so worthless, that it was difficult to find out, from some descriptions, to which of the specimens they were intended to apply.

In Mechanism and Applied Science book-work was satisfactorily done, but deductions and numerical applications were very imperfect. Drawing was well done, and the candidates also showed a practical acquaintance with the use of tools; but they did not sufficiently connect their mathematical with their practical knowledge.

In the previous examination or little-go, Jevons's logic was set as an alternative subject to Paley with considerable success last year. Out of forty-four candidates only six failed. In arithmetic a knowledge of decimals and the use of common sense were strikingly wanting. The gradual elevation of standard in Euclid and Algebra of late years appears to have produced beneficial results. The papers in Mechanics in the October examination (on entrance) were unsatisfactorily answered; the candidates had for the most part read treatises dealing with the subject incompletely and popularly.

The proposal to discontinue entirely the additional examination in Mathematics for Honours Candidates has been rejected by a large majority, it having been found impossible to provide any substitute which would command general assent.

Mr. M. C. Potter, Assistant Curator of the Herbarium, has been approved as a Teacher of Botany.

The Physiological class-rooms having again become seriously overcrowded, owing to the increase of the medical school, a scheme for building new class-rooms with a large lecture-room is put forward by the Museums and Lecture Rooms Syndicate. The lecture-room is to be 45 feet by 40, and 32 feet high, and is calculated to accommodate 247 students comfortably. A new class-room 80 feet long to accommodate 100 students working at one time is an important feature, and rooms will also be provided for Prof. Roy's temporary Pathological Laboratory. The estimate cost is 9000*l.*

SCIENTIFIC SERIALS

Journal of Anatomy and Physiology, January, contains:—Diseases of the reproductive organs in frogs, birds, and mammals, by J. B. Sutton (plate 8).—Oviduct in an adult male skate, by J. D. Matthews (plate 9).—On the influences of some conditions on the metamorphosis of the blow-fly, by J. Davidson.—On the sources and the excretion of carbonic acid at the liver, by J. J. Charles.—On a method of maceration, by A. M. Paterson (plate 10).—Floating kidney, by D. Hepburn.—The movements of the ulna in rotation of the fore-arm, by Thos. Dwight.—Dissection of a double monster, by A. Hill.—Relation of the alveolar form of cleft palate to the incisor-teeth and the intermaxillary bones.—The dumb-bell-shaped bone in the palate of Ornithorhynchus compared with the pre-nasal bone of the pig.—The infra-orbital suture; and an additional note on the oviducts of the Greenland shark, by W. Turner.—Anatomical notes.

Quarterly Journal of Microscopical Science, January, contains:—On the significance of Kupffer's vesicle, with remarks on other questions of vertebrate morphology (plate 1), by J. T. Cunningham.—Blastopore, mesoderm, and metameric segmentation, by W. H. Caldwell (plate 2).—On the origin of the hypoblast in pelagic teleostean ova, by G. Brook.—On the presence of eyes in the shells of certain Chitonidæ, and on the structure of these organs, by H. N. Moseley (plates 4, 5, 6).—*Archerina boltoni*, nov. gen. et sp., chlorophyllogenous protozoon allied to Vampyrella, by E. Ray Lankester (plate 7).—On the apex of the root in Osmunda and Todea, by F. O. Bower (plates 7 and 8).—Correction of an error as to the morphology of *Welwitschia mirabilis*, by F. O. Bower.—E. Van Beneden's researches on the maturation and fecundation of the ovum, by J. T. Cunningham (plate 10).—On the suprarenal bodies of vertebrata, by W. F. R. Weldon (plates 11 and 12).—On the life-history of certain British heterœcismal uredines, by C. Plowright.—On the occurrence of chitin as a constituent of the cartilages of Limulus and Sepia, by W. D. Halliburton.

Journal of the Royal Microscopical Society, February, contains:—On the apparatus for differentiating the sexes in bees and wasps. An anatomical investigation into the structure of the receptaculum seminis and adjacent parts, by F. R. Cheshire (plates 1 and 2).—On the occurrence of variations in the development of a Saccharomyces, by G. F. Dowdeswell.—Notes on the life-histories of some little-known Tyroglyphidæ, by A D. Michael (plate 3).—The usual summary of current researches in zoology, botany, and microscopy.

THE *American Naturalist*, February, contains:—On the habits of some Arvicolinæ, by E. R. Quick and A. W. Butler.—On a parasitic copepod of the clam, by R. R. Wright.—On the rudimentary hind-limb of Megaptera, and on the finger-muscles in *M. longimana* and in other whales, by J. Struthers.—The structure and development of the suspensory ligament of the fetlock in the horse, by J. D. Cunningham.—The Winooski or Wakefield marble of Vermont, by G. H. Perkins.—A botanical study of the mite-gall found in the black walnut, by Lillie J. Martin.—On the evolution of the Vertebrata, progressive and retrogressive, by E. D. Cope.

Rendiconti del Reale Istituto Lombardo, January 8.—Annual report on the work of the Institute in the various branches of science and letters during the past year, by the Secretary.—Biographical notice of Baldassare Poli, by Prof. Carlo Cantoni.

January 15.—On the secular variations in the elements of terrestrial magnetism at Venice, by Ciro Chistoni.—On a rare case of congenital malformation of the bladder, by Dr. G. Fiorani.—Extent of the diurnal oscillation of the magnet of declination at Milan in the year 1884, by Prof. G. V. Schiaparelli.—On the anatomy of the human brain, by Dr. Casimiro Mondino.—On

the appearance of Halley's comet in the year 1456, by Prof. G. Celoria.

Rivista Scientifico-Industriale, January 15.—Influence of static electricity on lightning conductors, by Prof. Eugenio Canestrini.—On Trouvé's universal incandescent electric lamps (four illustrations), by the Editor.—On the various forms of *Scleranthus marginatus*, Gussone, by Dr. Leopoldo Nicotra.

Zeitschrift für wissenschaftliche Zoologie, December 1884, contains:—Observations on the origin of the sexual cells in Obelia, by Dr. C. Hartlaub (plates 11 and 12).—Studies among the Amœbæ, by Dr. A. Gruber (plates 13 and 14).—On the propagation and development of *Rotifer vulgaris*, by Dr. O. Zacharias (plate 16).—On the amœboid movements of the Spermatozoa of *Polyphemus pediculus*, by Dr. O. Zacharius.—On the uropneustic system in Helicinæ, by Dr. H. v. Ihering (plate 17).—On the metamorphosis in Nephelis, by Dr. R. S. Bergh (plates 18 and 19).—On the intercellular spaces and bridges in epithelia, by P. Mitrophanow.

Morphologisches Jahrbuch, Band x. Heft 3, contains:—On the occurrence of spindle-shaped bodies in the yolk of young frog eggs, by Prof. O. Hertwig (plate 14).—Researches upon the *Pori abdominales*, by H. Ayers (plate 15).—Contribution to a knowledge of the eye in gastropods, by C. Hilger (plates 16 and 17), and a postscript by Dr. O. Bütschli.—Studies on the development of the medullary cord in bony fish, with observations on the first appendages of the germinal vesicle and the chorda dorsalis in Salmonidæ, by N. Goronowitsch (plates 18 to 21).—Dinosaurs and birds: a reply to Prof. W. Dames, by Dr. G. Baur.—On the carpi centrale, and on the morphology of the tarsus in the Mammalia, by Dr. G. Baur.—Remarks on the abdominal pores in fish, by Prof. C. Gegenbaur.

SOCIETIES AND ACADEMIES

London

Royal Society, January 13.—"On the Constant of Electromagnetic Rotation of Light in Bisulphide of Carbon." By Lord Rayleigh, F.R.S.

A complete account is here given of the experiments briefly referred to in the Preliminary Note,[1] and of others on the same plan of more recent date. As regards the method, it may be sufficient to add to what was there said, that the electric currents were estimated by comparing the difference of potential generated by the current in traversing a known resistance with that of a standard Clark cell, the value of the cell being known by converse operations, in which the current was measured by a special electro-magnetic apparatus.[2] Allowance being made for temperature, the determination of the currents by this method was abundantly accurate and very simple.

The results are grouped in three series, of which the first two were considered in the Preliminary Note. In both of them the same tube was used, the principal difference being that in the first the light traversed the tube three times, and in the second but once. In the third series another tube was employed, and some improvements in respect to thermal insulation were introduced. The readings were taken with a double-image prism in place of the ordinary analysing Nicol, a substitution by which it is believed some advantages were obtained.

From the fifteen sets of observations of Series I. we find as the rotation of sodium light in bisulphide of carbon at 18° corresponding to a difference of potential equal to unity C.G.S. the value ·04203 minute. From the four observations of Series II. we get in like manner ·04198 minute, and from the seven observations of Series III. ·04202 minute. The last value is adopted as the most probable.

In an appendix some remarks are made upon polarimetry in general, especially in relation to the half-shade method. A device proposed by M. Becquerel for augmenting the precision with which rotations can be determined with the aid of a half-wave plate is considered, and the conclusion is arrived at that no advantage can thus be obtained.

February 19.—"Note on a Preliminary Comparison between the Dates of Cyclonic Storms in Great Britain and those of Magnetic Disturbances at the Kew Observatory." By Balfour Stewart, F.R.S., and Wm. Lant Carpenter.

The authors had made this comparison, through the kindness of Mr. Whipple, in the case of about thirty storms, the dates of which were taken haphazard from those given by Mr. R. H. Scott in his paper on the cyclonic storms of the last ten years, in the *Quarterly Journal* of the Meteorological Society for October, 1884. Out of these thirty cases, in twenty-three there war a distinct magnetic disturbance, for the most part preceding the storm by somewhat more than a day. The authors intend to pursue the subject, considering that there is a *primâ facie* case for investigation.

Geological Society, February 20.—Annual General Meeting.—Prof. T. G. Bonney, F.R.S., President, in the chair.—The Council's Report announced the awards of the various medals and of the proceeds of the Donation Funds in the gift of the Society.—In handing the Wollaston Gold Medal to Dr. W. T. Blanford, F.R.S., for transmission to Mr. George Busk, F.R.S., F.G.S., the President addressed him as follows:—The Council of the Geological Society has awarded to Mr. George Busk the Wollaston Medal in recognition of the value of his researches in more than one branch of palæontology. Polyzoa, not only fossil, but also recent, he has made peculiarly his own, and his numerous separate papers, his British Museum Catalogue, and his memoir on the Polyzca of the Crag, have entitled him to the lasting gratitude of workers at this class of the Molluscoida. But, perhaps as a relief to the study of these minute invertebrates, he has occupied himself, not less successfully, with the larger vertebrata, so that to him we are indebted for much information on the fauna of Post-tertiary deposits, especially from the caves of Malta and of Brixham. Permit me, in handing you this medal for transmission to Mr. Busk, to express my pleasure at having such a duty to discharge, and my earnest hope, in which I am sure all present will share, that restored health may enable him to continue his work in the cause of our science.—The President then presented the balance of the proceeds of the Wollaston Donation Fund to Dr. Charles Gallaway, F.G.S., and addressed him as follows:—The Council of the Geological Society has awarded to you the balance of the proceeds of the Wollaston Donation Fund, in recognition of the value of your researches among the older British rocks. By your identification of Upper Cambrian rocks in Shropshire you have placed beyond question the antiquity of the Rhyolitic Group of the Wrekin, our knowledge of which and of yet older rocks in that district you have greatly augmented. Your contributions also to the geology of Anglesey and to unravelling the stratigraphy of the Scotch Highlands have been of great value, and we look forward to the results of further researches, in aid of which I have great pleasure in placing in your hands the amount of the award. That you receive it from a fellow-labourer will, I hope, make it not the less welcome. The President then handed the Murchison Medal to Dr. Henry Woodward, F.R.S., for transmission to Dr. Ferdinand Römer, F.M.G.S., of Breslau, and addressed him as follows:—The Council has awarded to Dr. Ferdinand Römer the Murchison Medal and a sum of ten guineas from the Donation Fund. His life-long and unwearied labours in the service of our science have long since made his name familiar to his fellow-workers. When I state that the Royal Society Catalogue, published now more than eleven years since, records the titles of 122 separate memoirs written by him, when I mention his other important works, such as that on "The Chalk Formation of Texas," on "The Silurian Fauna of Tennessee," on "The Geology of Upper Silesia," and the "Lethæa Geognostica," I have said enough to prove that this memorial of an illustrious geologist could not well have been bestowed on a more illustrious recipient. In transmitting it to Dr. Römer, be so kind as to express our regret that the distance and the season of the year have deprived us of the pleasure of his presence on this occasion. In presenting the balance of the proceeds of the Murchison Geological Fund to Mr. Horace B. Woodward, F.G.S., the President addressed him as follows:—The balance of the proceeds of the Murchison Donation Fund has been awarded to you in recognition of the good service which you have already rendered to geology, especially by your work among the later deposits of the eastern counties, and to aid you in further researches. But the excellent papers which you have written, in addition to the work done by you as a member of the Geological Survey, do not constitute your only claim to our recognition. You have made use of the opportunity of your official position to promote a love of science among those who live in our eastern counties, and we are indebted to you for that admirable volume, "The Geology of England and Wales," which, though in one sense a compilation, is such a one as only

[1] *Proc. Roy. Soc.* vol. xxxvii. p. 146.
[2] "On the Electro-chemical Equivalent of Silver, and on the Absolute electromotive Force of Clark Cells." *Proc. Roy. Soc.*, vol. xxxvii. p. 142.

a skilled geologist could produce. The President next presented the Lyell Medal to Prof. H. G. Seeley, F.R.S., F.G.S., and addressed him as follows:—The Council has awarded to you the Lyell Medal and a grant of 40*l.* in recognition of your investigations into the anatomy and classification of the Fossil Reptilia, especially the Dinosauria. Not that you have limited yourself to this field of research; your papers on *Emys* and *Psephophorus*, on *Megalornis* and British Fossil Cretaceous Birds, on *Zeuglodon*, and on remains of Mammalia from Stonesfield, prove your extensive knowledge of vertebrate palæontology, as your proficiency in invertebrate is evidenced by your earlier work, both stratigraphical and directly palæontological. Furthermore, your excellent edition of the first volume of Phillip's "Manual of Geology" indicates an exceptional familiarity with the literature of our science. Since our acquaintance first began, some twenty years since, at Cambridge, we have both had our disappointments and our successes; you, undiscouraged by the one, unelated by the other, have pushed on to your present high position in science, making no enemies, winning many friends. I trust that your future career may be even more prosperous than your past, and that this medal may be an augury of many good gifts of fortune. You will, I know, believe me when I say that I feel an exceptional pleasure in being commissioned to place in your hands this medal, commemorative of the great geologist whose philosophic spirit you so well appreciate, and whose memory, I know, you so greatly revere. The President then handed the balance of the proceeds of the Lyell Geological Fund to Mr. J. J. H. Teall, F.G.S., for transmission to Mr. A. J. Jukes-Browne, F.G.S., and addressed him as follows:—The balance of the Lyell Donation Fund has been awarded to Mr. A. J. Jukes-Browne in recognition of the excellent work that he has done on the Cretaceous formation and on glacial geology, and to aid him in further researches. His papers on the Cambridge greensand cleared up many difficulties connected with that interesting formation; and in his Sedgwick prize essay on the Post-tertiary deposits of Cambridgeshire he commenced those investigations which have since brought us more than one valuable contribution on glacial and later deposits. You can tell him that his old college tutor feels a little pardonable pride and much real pleasure in being the instrument of placing this award in your hands for transmission to him. In presenting the Bigsby Gold Medal to Prof. Renard, of Brussels, the President addressed him as follows:—When to a familiarity with geology in the field and a love of nature are united the skill of a finished chemist and the experience of a practised worker with the microscope, the results cannot fail to be of the utmost importance to our science. These qualifications, rarely united in any one man, are in yourself combined with an untiring industry and a love of science for its own sake. Thus we are indebted to you for many important contributions to our knowledge in geology. Your early memoir, "Sur les Roches Plutoniennes de la Belgique et de l'Ardenne Française," written in conjunction with M. de la Vallée Poussin, will long be classic; your papers on various subjects connected with the Carboniferous limestone, on the coticule, the phyllites, and other altered rocks of Belgium, and on the deep-sea deposits, are too well known to need more than mention, and in recognition of these the Council has awarded you the Bigsby Medal. In placing it in your hands may I be allowed to express for myself and others the hope that it will be always a pleasant *souvenir* of your many friends on this side of the Channel, some of whom, myself included, will not soon forget the pleasant and, to us, most profitable days spent under your guidance in geological studies by the limestone cliffs of the winding Meuse and the wooded crags of the Ardennes. The President then read his Anniversary Address, in which, after giving obituary notices of some of the members lost by the Society during the year 1884, he referred to the principal contributions to geological knowledge which have been made during the past year, both in the publications of the Society and elsewhere in Britain, concluding with a notice of the new views which have been adopted with regard to the structure of the Western Highlands, and a brief history of the steps by which they have been arrived at. The concluding portion of the address was devoted to a discussion of the principles of nomenclature which should be followed in petrology, with remarks on the classification of igneous rocks, and on the significance of certain structures, especially the more minute.—Officers and Council, 1885:—President: Prof. T. G. Bonney, F.R.S.; Vice-Presidents: W. Carruthers, F.R.S., John Evans, F.R.S., J. W. Hulke, F.R.S., J. A. Phillips, F.R.S.; Secretaries: W. T. Blanford, F.R.S., Prof. J. W. Judd, F.R.S.; Foreign Secretary: Warington W. Smyth, F.R.S.; Treasurer: Prof. T. Wiltshire, F.L.S.; Council: H. Bauerman, W. T. Blanford, F.R.S., Prof. T. G. Bonney, F.R.S., W. Carruthers, F.R.S., Prof. W. Boyd Dawkins, F.R.S., John Evans, F.R.S., A. Geikie, F.R.S., Henry Hicks, M.D., Rev. Edwin Hill, M.A., G. J. Hinde, Ph.D., John Hopkinson, W. H. Hudleston, F.R.S., J. W. Hulke, F.R.S., Prof. T. Rupert, F.R.S., Prof. J. W. Judd, F.R.S., J. E. Marr, M.A., J. A. Phillips, F.R.S., Prof. J. Prestwich, F.R.S., Warington W. Smyth, F.R.S., J. J. H. Teall, M.A., W. Topley, Prof. T. Wiltshire, F.L.S., Rev. H. H. Winwood, M.A., Henry Woodward, F.R.S.; Assistant-Secretary, Librarian, and Curator: W. S. Dallas, F.L.S.; Clerk: W. W. Leighton; Library and Museum Assistant: W. Rupert Jones.

Physical Society, February 28.—Prof. Guthrie, President, in the chair.—Messrs. G. R. Begley and O. Chadwick were elected Members of the Society.—Mr. J. C. McConnel presented two notes on the use of Nicol's prism. The first note related to the error in measuring a rotation of the plane of polarisation due to the axis of rotation of the prism not being parallel to the emergent light. After pointing out that this error was, to a first approximation, eliminated by taking the mean of the readings in the two opposite positions of the Nicol, the author proceed to push the calculation to a second approximation, so as to get a measure of the residual error. This is given by the equation—

$$\frac{\theta + \theta_1}{2} - \psi = \text{const.} + .\ 24r^2 \sin \psi \cos \psi,$$

where θ and $180 + \theta_1$ are the two readings of the circle; ψ the angle between the plane of polarisation and a fixed plane, and r the angle between the axis of rotation and the incident light. This equation is practically correct for a flat-ended as well as an ordinary Nicol. The residual error cannot amount to $1'$ in a rotation of $60°$ if r is less than $2°$. The optical properties of the Nicol tend to neutralise the geometrical error due to the rotation taking place about one axis and being measured about another. The second note dealt with a new method of obtaining the zero reading of a Nicol circle. This is often defined as the reading when the plane of polarisation is parallel to the axis of rotation of the table of a spectrometer. A Nicol is fixed on the table, the light quenched by turning the Nicol circle, and the reading taken. The table is then rotated through 180°, the light quenched, and the reading taken again. The mean of the two readings gives the result required. It was described how the error due to the want of symmetry of the Nicol might be found and eliminated.—Mr. H. G. Madan exhibited and described some new forms of polarising prisms. The first of these is by M. Bertrand, and has been described by him (*Comptes Rendus*, September 29, 1884). The prism consists of a parallelopiped of dense flint glass of refractive index 1·658, the same as that of Iceland spar for the ordinary ray. The glass prism is cut like the spar of a Nicol's prism, a cleavage plate of spar being cemented between the two halves by an organic cement of refractive power slightly greater than 1·658. A beam of light traversing the prism is incident upon the spar at an angle of 76° 44′. The ordinary ray passes through without change, but the extraordinary ray is totally reflected at the first surface. The prism gives a field of 40°. M. Bertrand's prism has the great advantage of requiring only a very small quantity of Iceland spar, a substance that is becoming very scarce and expensive. The other prisms shown were: a similar one by M. Bertrand, described in the same paper; a double-image prism by Ahrens, described in the *Phil. Mag.* for January, 1885; and a modification of the latter by Mr. Madan, described in NATURE for February 19. Mr. Lewis Wright pointed out as a practical objection to M. Bertrand's prism that it was very doubtful whether a glass could be obtained of so high a density as to possess a refractive index of 1·658 and at the same time be colourless and unaffected by the atmosphere. He also remarked that the principle of the prism was by no means new.—Prof. W. E. Ayrton read a paper by himself and Prof. J. Perry on "The most economical potential difference to employ with incandescent lamps." The authors commenced by pointing out the importance of experiments being made on the lives of incandescent lamps, in addition to experiments on efficiencies. Referring to the experiments on life given by M. Foussat in *The Electrician* for January 31, they showed that if p be the price of a lamp in pounds, n the number of hours per year that it burns, $f(v)$ the

life of the lamp in hours, and $\theta(v)$ the number of candles equivalent to the lamp, $f(v)$ and $\theta(v)$ being expressed as a function of the potential difference in volts $\frac{p \times n}{f(v) \times \theta(v)}$ stands for the cost per year per candle, as far as the renewal of lamps is concerned. Also, if H stands for the cost of an electric horse-power per year for the number of hours electric force is employed, and $p(v)$ the number of watts per candle, $\frac{H}{746} \times p(v)$ stands for the cost per year per candle as far as the production of power is concerned. The sum of these two represents the total cost per candle per year, and the value of v that makes this a minimum may be found either graphically or analytically. Solving the problem graphically for the 108 volt Edison lamps used at the Finsbury Technical College, where n may be taken as 560 and $H = 5l.$, they find that the minimum value of the total cost is given by $v = 106$. The curve connecting total yearly cost per candle with v they found to be very flat at this point, showing that the lamps may be burnt with a potential difference varying as much as 4 volts, with only 5 per cent. addition to the annual cost. It is found that with certain types of incandescent lamps the candle-power of the lamp varies as the potential difference minus a constant. The authors also find that in rough photometric experiments No. 8 sperm candles may be substituted for standard ones.—Mr. Macfarlane Gray gave an account of a most extended investigation upon the second law of thermodynamics. From considerations connected with the specific heats of liquids and gases the author comes to the conclusion that the second law is not true. The experimental results used are chiefly those of Regnault, to which, however, Mr. Gray has applied some corrections.

EDINBURGH

Royal Physical Society, February 18.—The Rev. Prof. J. Duns, D.D., F.R.S.E., President, in the chair.—The following communications were read, viz.:—Prof. W. Turner, F.R.S., exhibited and described a collection of fossil bones of mammals obtained in excavating the new dock and a gas-holding tank at Silloth. He was indebted for these to Dr. Leitch, Mr. Charles Boyd, and Mr. J. T. Middleton. The specimens consisted of antlers and a humerus of the Red Deer, vertebræ of two whales and two skulls and some of the bones of the limbs of the great extinct ox of Britain, *Bos primigenius*. Those found in excavating the dock were within a short distance of each other, lying in a bed of wet gravel and shingle, mixed with oyster, mussel, and cockle beds, the material overlying the bones being twenty-six feet in thickness. One of the antlers contained eight points, and it is doubtful if a finer specimen could be found on any existing red deer. The lower jaw of one skull of the *Bos primigenius* was obtained, and it is apparently the only specimen that had been seen in Britain, and, comparing it with the wild cattle in Cadzow Forest, he found that the extreme length of the jaw of the fossil ox was 18¼ inches, as against 15⅝ inches in the Hamilton cattle, being a difference of nearly 3 inches. The leg bones also showed the massive character of the Great Ox, and enabled the Society to realise its magnitude.—Dr. R. Milne Murray, M.A., M.R.C.P.E., described and exhibited some new modifications of recording apparatus.—Dr. Ramsay Traquair, F.R.S., described and exhibited a new fossil fish, *Elonichthys multistriatus*, found in the black-band ironstone at Gilmerton.—Mr. George Brook, F.L.S., described a new method for the aëration of marine aquaria.—Mr. John Hunter, F.C.S., read a paper on a new modification of Lunge's nitrometer.—Prof. A. G. Nathorst and Prof. Gustav Lindström, of Stockholm, have been elected Corresponding Fellows of the Society.

Institution of Civil Engineers, February 19.—Sir Frederick J. Bramwell, F.R.S., President, in the chair.—The second of a course of lectures on "The Theory and Practice of Hydromechanics" was delivered by Dr. William Pole, F.R.SS., L. and E., M.Inst.C.E., Honorary Secretary of the Institution, the subject being "Water Supply."

CAMBRIDGE

Philosophical Society, February 16.—Prof. Foster, President, in the chair.—The following communications were made to the Society:—Some remarks on the urea-ferment, by Mr. A. S. Lea.—On the occurrence of reproductive organs on the root of *Laminaria bulbosa*, by Mr. Walter Gardiner.—On the types of excretory system found in the Enteropneusta, by Mr. W. Bateson.

SYDNEY

Linnean Society of New South Wales, December 31, 1884.—C. S. Wilkinson, F.L.S., President, in the chair.—The following gentlemen were present as visitors:—Messrs. W. H. Caldwell, B.A., C. E. Smith, James Mosely, Alex. Hamilton.—The following papers were read:—Occasional notes on plants indigenous in the immediate neighbourhood of Sydney, No. 8, by Edwin Haviland.—The geology and physical geography of the State of Perak, by the Rev. J. E. Tenison-Woods, F.G.S., &c.—Note on an apparently new parasite affecting sheep, by R. von Lendenfeld. In several localities sheep were affected by a disease similar in appearance to epithelial cancer, which appeared on the feet behind the hoofs and on the lips. The histological investigation shows that the rete malphigii is inflamed and the Papillæ attain a very large and abnormal size; the outer layer of the skin and the horny epithelium are very much thickened, and it is apparent that between the horny layer granular masses, apparently parasites, are disposed, in which nuclei can be detected. The author supposes these to be an Amœba, and to cause by irritation the hypertrophy of the epithelium. The sections were exhibited under the microscope; the specimens were hardened with chromic acid and stained with picric acid carmin.—On the temperature of the body of *Ornithorhynchus paradoxus*, by N. de Miklouho-Maclay. The result of some observations on the temperature of the *Ornithorhynchus* is here given, showing it not to exceed 40° C. or 76° Fahr. Previous observations made by the Baron had shown that the temperature of the body of the Echidna was at least 5° Fahr. higher than that of the other Monotreme.—Mr. W. H. Caldwell, B.A., exhibited several specimens which he had recently obtained in Queensland, showing the stages in the development of the Monotremes from the laying of the egg to the hatching.—Mr. J. Mitchell, of Bowning, exhibited a large number of Silurian fossils collected by him in the neighbourhood of Bowning. They consisted of a variety of mollusks, corals, and about sixteen species of trilobites. Among the trilobites are *Phacops caudatus*, *P. longicaudatus*, *P. encrinurus punctatus*, and *P. Jamesii* (?), *Calymene* (*Lenaria?*), *Harpes ungula*, *Staurocephalus Murchisonii*, *Bronteus*, and several of the genus *Acidapsis*, one of which attained a considerable size. The mollusks included representatives of *Pentamerus*, *Orthoceras*, *Avicula*, *Strophomena*, &c.

PARIS

Academy of Sciences, March 2.—M. Bouley, President, in the chair.—Note on "Les Origines de l'Alchimie," by the author, M. Berthelot. In this work the origin of alchemy, forerunner of the modern science of chemistry, is traced back by means of Greek manuscripts and Egyptian papyruses to the remotest historic times.—Researches on isomery in the aromatic series; heat of neutralisation of the polyatomic phenols, by MM. Berthelot and Werner.—Observations of the small planets and of Wolff's comet made with the great meridian at the Paris Observatory during the last quarter of the year 1884, communicated by M. Mouchez.—On the periodicity of the solar spots, and the anomaly of their last maximum, by M. Faye. The periodicity is regarded as established, and the irregularity in the last maximum is referred to a possible quasi independence of the northern and southern solar hemispheres, in virtue of which the epochs of their respective greatest activity may not coincide exactly.—First explorations of the mission sent by the Academy to study the recent earthquakes in the south of Spain, by M. Fouqué. The mission, consisting of MM. Fouqué, Lévy, Bertrand, Barrois, Offret, Kilian, and Bergeron, arrived at Malaga on February 7, and from that point visited Periana, Zaffararia, Venta de Zaffararia, Alhama, Arenas del Rey, and Albuñuelas, which places suffered most during the disturbances.—On a characteristic reaction of the secondary alcohols, by M. G. Chancel.—Action of oxygenated water on the oxides of cerium and thorium, by M. Lecoq de Boisbaudran.—Correction of a previous communication (*Comptes Rendus*, February, 1879, p. 322) regarding the spectrum of Samarium, by M. Lecoq de Boisbaudran.—On the prevailing winds of North Persia, and on the south wind of the province of Ghilan, by M. J. D. Tholozan.—Report of the International Commission for the widening and deepening of the Suez Canal, presented by M. de Lesseps.—Election of M. Grand' Eury as Corresponding Member for the Section of Botany in place

of the late M. Duval-Jouve.—Reply to some of the criticisms, formulated in connection with the note of January 5, on the reproduction of phylloxera and the employment of the sulphate of carbon for its destruction, by M. P. Boiteau.—On the spectrum and formation of the tail of Encke's comet, by M. Ch. Trépied.—On a theorem of M. Darboux in mathematical analysis, by M. E. Picard.—The poles of the gyroscope and rotating solids in connection with Coriolis's theorem, by M. Henry.—On the maxim phase in the diurnal variations of terrestrial magnetism in 1882, according to the results obtained at the Montsouris Observatory, by M. L. Descroix.—Claim of priority in respect of the process of annulation of the extra current employed by M. d'Arsonval to avoid the dangers of mechanical generators of electricity, by M. A. Doussin.—On the means of counteracting or diminishing the dangers of the extra current in dynamo-electric machines in case of rupture in the exterior circuit, by M. J. Raynaud.—On the limit of density and atomic value of the gases, and especially of oxygen and hydrogen, by M. E. H. Amagat.—Composition of the gaseous products of the combustion of iron pyrites, and influence of Glover's tower on the production of sulphuric acid, by M. Scheurer-Kestner.—On the separation of alumina and the sesquioxide of iron, by M. P. Vignon.—On some basic and ammoniac nitrates, by M. G. André.—On the composition of the glyoxal-bisulphate of ammonia ($C_4H_2O_4$, $2(AzH_4O, S_2O_4)$, $2HO$), by M. de Forcrand.—Action of the sulphate of cinchonamine on the circulation and secretions, by MM. G. Sée and Bochefontaine.—On the substitution of quinine for creosote and phenic acid in the treatment of typhoid fever, by M. G. Pécholier.—Measure of the pressure necessary to determine the rupture of blood-vessels, by MM. Gréhant and Quinquaud.—On some peculiarities relative to the connections of the cervical ganglia of the sympathic nerve and the distribution of their afferent and efferent branches in *Anas boschas*, by M. F. Rochas. — On the nature of the placental neo-formation, and on the unity maintained in the development of the placenta, by M. Laulanie.—Note on the fœtus and placenta of a gibbon, by M. J. Deniker.—On some points in the physiology of the muscular system of the invertebrates, by M. H. de Varigny.—On *Bos triceros*, Rochbr., and on preventive inoculation against epizootic peripneumonia as practised by the Moors and Fulahs of Senegambia, by Dr. A. T. de Rochebrune. This variety of domestic ox, peculiar to Senegambia, is characterised by a third horn growing from the nasal process and identical in its constitution and development to the two frontal horns. The variety, which is of unknown origin, is thoroughly established, and from time immemorial has been inoculated by the natives with the virus of epizootic peripneumonia, a disease prevalent in the country.—On the mosses of the Carboniferous epoch, by MM. B. Renault and R. Zeiller.—Origin of the iron, magnesia, and zinc ores in and at the foot of the Jurassic Limestone hills on the periphery of the central plateau in France, by M. Dieulafait.—On a remarkable deposit of running water in the mines of Carmaux, Tarn, by M. Stan. Meunier.—Destructive effects of a waterspout which recently passed over the Argentan district, Orne, by M. E. Vimont.—A new method of observing stars during their transit across the meridian, by M. Ch. V. Zenger.

BERLIN

Physiological Society, February 13.—Prof. Fritsch produced a few specimens of *Lophius piscatorius*, and drew special attention to the two rays situated above the wide gape, and ending in flap-like appendages, which in some had the shape of a fly, in others that of a worm, and were used by the fish as bait to attract its prey. The jaws and fins were likewise covered with flap-like appendages, excrescences of the skin, which rendered the animal, especially in mud, completely irrecognisable. The peculiar development of the skin of this fish induced the speaker to search for corresponding peculiarities in its nervous system—peculiarities which he soon discovered in its medulla oblongata. He found there, on the posterior side of the medulla, and quite superficially situated, a group of huge ganglion-cells, recognisable by means of a lens, such as had hitherto been found only in Malapterurus. While, however, this latter fish possessed but two such gigantic cells, Lophius had a larger number of them, and these offered for study a series of general problems on the structure of ganglion cells. The protoplasm of these colossal nerve-cells was not fibrous, but granular, the nucleus large and bladder-like. The nutriment was provided by a close capillary net which closed tightly around the protoplasm and sent loops into its recesses. The cells were multipolar, yet one process, which in every case was the peripherical, preponderated in size over all the others. From these cells there branched off gigantic nervous fibres consisting of powerful fibrous axis cylinders and sheaths. Such gigantic nerves were found partly also in the roots of the vagus and trigeminus, and probably spread to the peculiar cuticular appendages of Lophius. Altogether Prof. Fritsch believed he was justified in concluding from what he had observed in his investigations of the ganglion-cells of Lophius, that there were neither apolar nor unipolar ganglion-cells, but only bipolar and multipolar, and that the processes of the ganglion-cells might unite, so that frequently an axis-cylinder would be produced from two ganglia.—Dr. Uhthoff spoke in detail of the experiments carried out by him in the Physical Institute regarding the dependence of visual acuteness on light intensity. By way of supplement to the report on the subject given by Dr. König at a recent meeting of the Physical Society, be it here observed that differences among the eyes examined showed themselves specially under weak light intensities, and that the minimum of visual acuteness (1-1000th of the normal value) was, in particular cases, still observable under an illumination corresponding with the removal of the petroleum lamp to a distance of 360 m. The visual acuteness was further examined under a changing intensity with red and blue light. Red light, just as much as white, showed with increasing intensity a very rapid increase of visual force. The curve in the case of red light was, however, different from that in the case of white light. Under a blue light the visual sharpness very slowly declined with increasing light intensity. Dr. Uhthoff next described an apparatus he had constructed for the purpose of measuring the angle of the visual line with the line perpendicular to the cornea, without the use of the ophthalmometer. The principle of the apparatus was based on measuring the angular displacement of a plane paralleled glass plate, the glass plate standing perpendicular first to the normal and then to the (actual) visual line. Both the apparatus of Dr. Uhthoff and the microscopical preparations of the gigantic ganglion-cells and fibres of Lophius were shown to the Society in the demonstrating hall.

CONTENTS

THURSDAY, MARCH 19, 1885

THE DEBATE ON VIVISECTION AT OXFORD

IN our last issue we gave a brief notice of the proceedings in an overflowing Convocation at Oxford, which resulted in a majority of 412 votes to 244 in favour of the decree promulgated by the Hebdomadal Council. This decree had only an indirect bearing upon the question of vivisection; but as it was made an occasion for a fresh, and, let us hope, a final trial of strength between the scientific and anti-scientific forces of the University, it is desirable to furnish our readers with a somewhat more full account of what took place than we had time to print last week. Seeing that the debate had clearly been organised with no small amount of care on the side of the anti-vivisectionists, and that the ablest as well as the most authoritative speakers in Oxford who could support their cause were put forward, we may regard the arguments which were adduced as a fair example of the best that can be said against vivisection by cultured thought and cultured speech. We will therefore confine our remarks to what was said on this side of the question.

Regarded as a piece of oratory, the speech of Canon Liddon was, in our opinion, perfect; and the effect of what we may term an artistic eloquence was enhanced by the appearance and costume of the speaker, as well as by the appropriateness of his surroundings in the densely crowded Sheldonian Theatre. But when we look from the manner to the matter of his speech, we are unable to bestow such unqualified praise, although we confess that even here we were agreeably surprised by the judicious moderation of its tone. His views, briefly stated, were that so long as we hold it morally lawful to kill animals for food, or otherwise to use them for our own purposes, so long must we in consistency hold that, under certain circumstances, it is morally lawful to inflict pain upon animals for the benefit of man: the special case of vivisection does not differ in principle from other cases where pain is thus inflicted; but it ought to be qualified by three conditions—it should be resorted to as rarely as possible, it should be guarded against the instinct of cruelty, and it should be so used as not to demoralise spectators. With all this every physiologist would of course agree. The Canon, however, proceeded to talk what in the strictest meaning of the word must be termed nonsense, when he affirmed that physiology might be "divorced" from vivisection. That this statement has gained currency among the anti-vivisectionists does not alter its essentially unreasonable character. It is perfectly true that in many departments of physiological research vivisection is not required; but it is no less true that in many other departments vivisection is an unconditional necessity. This fact, one would think, admits of being rendered obvious to any impartial mind, howsoever ignorant of physiological science. For if this science consists in the study of vital processes going on in the living organism, does it not obviously follow that some of them can only be studied while actually taking place? How, for example, would it be possible to gain any knowledge of the electrical and other changes which occur in a gland during the process of secretion, except by estimating these changes during the act of secretion? The gratuitous information which physiologists receive from technically ignorant sources touching the nature and the value of their own methods, can only suggest the presumption of inexperienced youth when venturing to instruct a maternal grand-parent in the practical aspects of oology.

It appears that Prof. Burdon-Sanderson had pledged himself not to exhibit vivisections to his class for the purposes of teaching, and for this concession to the unreasoning prejudice of his opponents he received a warm expression of gratitude from Canon Liddon. Probably enough, under the circumstances in which he is placed, the concession is a prudent one; but that it merited the eulogium which was bestowed upon it by Canon Liddon on moral grounds, no man of common sense could very well suppose. Demonstrations on the living subject, if performed in a class-room at Oxford, would of course be always performed on animals under the influence of anæsthetics; and therefore the "demoralising" effects upon the minds of young men, which Canon Liddon takes to have been averted by Prof. Sanderson's concession, can only be understood to consist in disregarding the mawkish sentimentality which cannot stand the sight of a painless dissection. This kind of "morality" may be regarded as tolerable in a girl: in a man it is not tolerable, and deserves the same kind of pitying contempt as is accorded to personal cowardice, with which it is most nearly allied.

Canon Liddon, however, regretted that Prof. Sanderson had not further pledged himself to restrict his experiments *for the purposes of research* to animals kept under the influence of anæsthetics during the operations, and killed before recovering from their anæsthesia. We have no doubt that Prof. Sanderson might have complied with the first of these suggestions without any serious detriment to his future researches. For, as a matter of fact, the cases in which anæsthetics interfere with the progress of an experiment are, comparatively speaking, very rare indeed, except where the occurrence of pain forms a necessary part of the experiment—*i.e.* in certain researches on the functions of sensory nerves. But as all the functions of sensory nerves which require for their study the infliction of pain have already been worked out, physiology as it now stands does not demand the absence of anæsthetics, save in a very small per centage of operations. Therefore, when pain is inflicted during an operation, it is due, as a rule, not to the exigencies of research, but to the indifference of the operator—a fact which we think physiologists ought to be more insistant than they are in impressing upon the mind of the public. Nevertheless, we feel persuaded that Prof. Sanderson was perfectly right in not binding himself never to operate without anæsthetics; for by so doing he would have virtually conceded the principle that the suffering of an animal is too great a price at which to buy an advance of knowledge; and this, among other things, would have been to place a moral stigma upon some of the most valuable researches of the past. Besides, as was pointed out in the course of an able speech by Prof. Dicey, it is not desirable that the *status* of a Professor in the University should be regarded as beneath that of a gentleman; and if it is supposed that Dr. Sanderson is not to

be trusted in the latter capacity, he ought never to have been chosen to fill an Oxford chair. In short, as the representative of physiology in Oxford, Dr. Sanderson, by the nature and extent of his concession, has drawn a clear distinction between the importance of teaching and of research: he has consented to allow the teaching to suffer if needs be; but he will not consent to yield an inch where the principles of research are concerned.

The other suggestion which was thrown out by Canon Liddon—namely, that a Professor of Physiology ought to pledge himself to kill every animal before it recovers from its anæsthesia—is, from every point of view, absurd. In the first place, the suggestion can only emanate from the uninformed supposition that the pain of a healing wound is considerable. But we know from the experience of hospital practice that even the most severe wounds are painless while healing, unless the process of healing is complicated by morbid conditions, which now admit of being wholly prevented by antiseptic methods. As a matter of fact, therefore, in our physiological laboratories, as in our surgical wards, there is at the present time but an extremely small amount of suffering to be found in connection with the healing of wounds; and no man of ordinary sense who had ever seen the inside of either the one or the other would have cared to make the suggestion which we are considering. But, in the next place, even if this were not so, it would have been highly wrong in any Professor of Physiology to restrict himself to the performance of experiments the objects of which could be secured during the action of an anæsthetic. Certainly more than half the experiments which the physiologist has now to perform have reference to questions of after-effects, and this is especially the case in experiments bearing upon the problems of pathology.

The speech of the Bishop of Oxford was bad, both in logic and in taste. It was bad in logic because in arguing for the total suppression of physiological research in Oxford, he relied upon foreign practice for his evidence of cruelty. This was essentially illogical, because it fails to distinguish between two very different things—namely, the cruelty, if any, which attaches to vivisection *per se*, and the cruelty which arises from other sources. If the state of public feeling in some foreign countries is not so sensitive as it is in our own on the matter of inflicting pain upon the lower animals, it is obviously unfair to search through the Continent for instances of cruelty in connection with physiological research, and then to adduce such instances as proof of cruelty necessarily attaching to physiological research at home. We might as well argue against the use of mules in England because these animals are badly treated in Spain. As we have already said, there are now but extremely few cases possible in which the occurrence of pain is necessary for the purposes of an experiment; and therefore the proof of pain having been inflicted in any one case constitutes proof, not of the pain-giving character of vivisection in general, but of the carelessness of some operator in particular. The cruelty must belong to the individual, not to the methods; and we are not aware that any charge of cruelty has hitherto been proved against an English physiologist.

The Bishop of Oxford's speech was bad in taste, because he sought, missionary-wise, to tell some anecdote of horror, which the good sense of Convocation prevented him from narrating further than that the subject of his story was to have been "an affectionate little dog." But, as he was not able to give any reference to the scene of his tragedy, after a prolonged battle with his audience upon this somewhat necessary proof of authenticity, he was obliged to give way. His taste was perhaps still more questionable when, in the presence of Prof. Sanderson and other working physiologists, he proceeded to adduce the favourite argument that the pursuit of experimental physiology exercises a baleful influence on the moral nature. That the argument is unsound, both in principle and in fact, we need not wait to show.

The speech of Prof. Freeman was rendered wholly inaudible by a general uproar, which proceeded chiefly from the side which he rose to support. We were told that this was due to the memory of the effect which was produced by his speech on the occasion of the previous vote.

Upon the whole we think that the debate was of no little service to the cause of physiology in Oxford; and when we consider how largely the majority of votes has grown since the first of the three divisions, we are glad to congratulate the University upon having shown so emphatically that, not less than her sister, she is able to withstand the assaults of the two great enemies of learning—Ignorance and Fanaticism.

THE RELATIVE EFFICIENCY OF WARSHIPS

IN our last week's issue we published a letter from Sir Edward Reed adverting to some points in an article which appeared in our number of February 26 upon "The Relative Efficiency of War Ships." In order to show the difference existing between the ships of the *Inflexible* or *Agamemnon* class and those of the *Admiral* class, as regards height of armour above the water, we then gave profiles of the *Agamemnon* and of the *Collingwood* (one of the *Admiral* class). We now give outline sections of the same vessels, in which this large difference can be more clearly seen, and by means of which its importance can be better understood.

Before giving any figures in connection with this question it may be as well to mention another point which, taken alone, is not unworthy of notice. We refer to the difference between the *Agamemnon* and *Collingwood* with regard to depth of armour below the water. When the *Agamemnon* is floating in smooth water, with her unarmoured ends uninjured, the depth of her armour below the water-line is 5 feet 10 inches, whereas that of the *Collingwood*, under the same conditions, is only 5 feet, as shown in Figs. 1 and 2 respectively. This difference of nearly 1 foot is of some importance, because every two or three inches gained in depth of armour below the water means a large increase in the safety of the ship when fighting at sea. When the ends of the *Agamemnon* are flooded she sinks 22 inches deeper in the water, and the depth of her armour below its surface would, therefore, then be 7 feet 8 inches (Fig. 3). The *Collingwood*, when her ends are flooded, sinks $17\frac{1}{2}$ inches deeper in the water, and in that condition, therefore, her armour would be 6 feet $5\frac{1}{2}$ inches below the water's surface (Fig. 4), or 1 foot $2\frac{1}{2}$ inches less than that of the *Agamemnon*. In the earlier ironclads it was considered necessary to carry

the armour to a depth of at least 6 feet below the normal water-line, and as much deeper as individual cases would allow. It is evident, therefore, that the ships of the *Admiral* class are deficient in this respect unless and until their unarmoured ends are flooded.

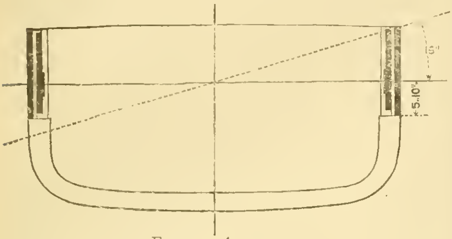


FIG. 1.—*Agamemnon.*

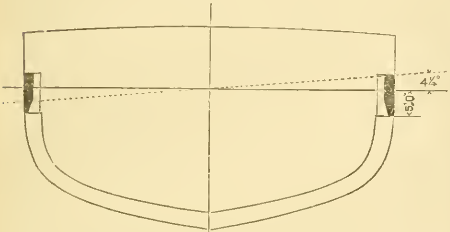


FIG. 2.—*Collingwood.*

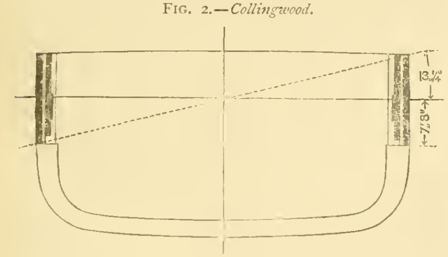


FIG. 3.—*Agamemnon.*

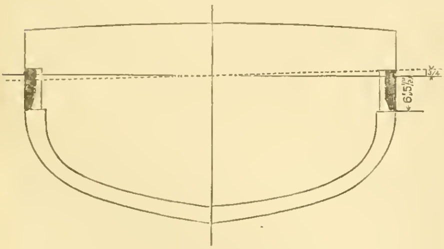


FIG. 4.—*Collingwood.*

Reverting to the still more important question of height of armoured freeboard (*i.e.* the height of the top edge of armour at side above the water), we will now give some figures. The *Agamemnon*, with her armoured freeboard of 9 feet 6 inches in the uninjured condition, can be inclined to the angle of 16 degrees before the top edge of her armour touches the water, as shown by the dotted line in Fig. 1; and even when her unarmoured ends are flooded, and her freeboard therefore reduced to 7 feet 8 inches, she can still be inclined (assuming for the moment that she would still have stability) to the angle of 13¼ degrees before her armour is brought beneath the water; this is shown in Fig. 3. But the *Collingwood* has so ridiculously shallow a partial belt (only 2 feet 6 inches above the water in the uninjured condition) that an inclination of only 4½ degrees causes her armour to disappear altogether in smooth water. When her ends are flooded her armoured freeboard is actually reduced to no more than 12½ inches, which is as much as to say that at sea she would have no armoured freeboard at all in that condition, for an inclination of but 1¾ degrees is sufficient to bury her armour completely, even in smooth water. The two conditions of the *Collingwood* are shown in Fig. 2 and Fig. 4 respectively.

These alarming facts, thus clearly brought into view are of themselves sufficient to explain Sir Edward Reed's distrust of the *Admiral* class of ship, and his very strong condemnation of these ships can be readily understood when we remember, further, that in his opinion the excessive shortening of the armoured part in the whole of these ships has introduced such elements of danger into them as to render them unfit to take their place in the line of battle, even apart from the considerations previously set forth.

THE AMERICAN ASSOCIATION

Proceedings of the American Association for the Advancement of Science (Thirty-Second Meeting), held at Minneapolis, Minn., August, 1883. (Salem: Published by the Permanent Secretary, 1884.)

THE record of the proceedings of the thirty-second meeting of the American Association forms a volume considerably less bulky than that issued by the British Association, as it consists of 598 pages, the corresponding volume of the older Association numbering 884 pages. The difference between the two volumes, as records of science, is about in the same proportion. Addresses, reports, and abstracts of papers take up 468 pages in the book before us, while in the Southport volume the same subjects occupy 660 pages. In printing and paper the American volume is decidedly the superior of the British, but, as a set-off, it is issued in a paper cover; the price, however, is only 1·50 dollars. The smaller size of the volume is accounted for by the fact that considerably fewer papers appear to have been read before the American Association than before the British. We note also another point of difference, certainly not to the advantage of the American volume: the reports on the state of science, so conspicuous and valuable a feature in the British volume, are remarkable in the American chiefly by their absence. We venture to suggest to the officers and Committee of the latter Association that they would add largely to its importance and stability by developing this branch of its work. At the present time, when scientific societies for special purposes are so numerous, their meetings and journals will always compete successfully with those of an all-embracing Association such as the British and others formed on a similar plan

for original papers of real importance; but the task of recording progress, of acting as the historians of science, is rightly declined by societies which aim at advance rather than at retrospect. Hence this most important function can be best discharged by these great Associations, and it will always suffice to save them from degenerating into scientific camp-meetings or picnics.

The Sections in the American Association are equally numerous with those in the British at the present time, though differently arranged. Mathematics and Physics are divided, Geology and Geography united; Histology and Microscopy form a section separate from Biology. We doubt the advantages of the union in the second case, and of the separation in the third. That no address is printed in this volume, and that the only record of the proceedings of the Section of Histology and Microscopy is the statement that, although some meetings took place, no papers were read before it, seems an indication that, as in Britain, its subjects might safely be merged in Biology, the latter Section having the power of temporary subdivision.

In another respect too the American differs from the British Association. In the latter the delivery of an address is the first official act of its President, in the former it is the last. The address at Minneapolis was delivered by Principal (now Sir William) Dawson, and is characterised by the scientific caution and literary ability of its author. It gives a critical sketch of the results of geology, more especially with reference to the development of the earlier rocks and to the evolution of living creatures. In regard to the former, Sir W. Dawson inclines to drawing a marked line of separation between the Lower Laurentian or Ottawa gneiss of Sir W. Logan and the Middle Laurentian or the Grenville series of the same, which is characterised by beds of limestone and dolomite, "quartzite, quartzose gneisses, and even pebble beds," besides graphite, iron ore, and the debatable *eozoon*, which Sir W. Dawson considers as indicating the existence of land surfaces of the fundamental gneiss. The Upper Laurentian or Norian series is noticed with due caution, though it is regarded as decidedly younger than the preceding formation. The Huronian, Montalban, and Taconian (Lower Taconic of Emmons) are next mentioned, but the author, though inclining to the views of Dr. Sterry Hunt as to their order of succession, forbears to dogmatise as to their precise relations either mutually or with "certain doubtful deposits around Lake Superior." With regard to the development of life, he is decidedly adverse to the evolution school among biologists, but is not able to add anything material to the familiar arguments of its opponents. The address concludes with a brief notice of some of the obscure markings, variously referred by palæontologists to algæ, protozoa, and tracks of various animals, and with a critical sketch of the theories relating to the Glacial Epoch, in which he expresses himself as opposed to the extreme views of the former extension of land-ice and its erosive action which are favoured by some geologists.

Two other papers are given as "read in General Sessions," which we presume may be regarded as in some respect analogous with the evening discourses at the British meetings. The one by Dr. Sterry Hunt, "On a Classification of the Natural Sciences," is printed in abstract only; the other, by Prof. E. D. Cope, entitled "The Evidence for Evolution in the History of the Extinct Mammalia," is an extremely able and temperate sketch of the views antagonistic to those entertained by the retiring President. "The German Survey of the Northern Heavens" forms the subject of an interesting address by Prof. W. A. Rogers, who presided over the section of Mathematics and Astronomy, and Prof. H. A. Rowland delivered a "Plea for Pure Science" to the section of Physics. Both these sections received a considerable number of communications. The section of Chemistry does not appear to have had a special address, and the number of papers read before it was not large. The same may be said of the Mechanical Section, in which only seven papers are recorded as read. Prof. Hitchcock, in the section of Geology and Geography, took the "Early History of the North American Continent" as the subject of his address, in which he favours the idea that the bulk of the early crystalline rocks are of igneous origin, being metamorphosed volcanic rocks or tuffs. Ice and its leavings form the subject of a large proportion of the papers read before this section. More than one of these is of much interest, especially that by Mr. W. Upham on the Minnesota Valley in the Ice Age. Messrs. H. C. Bolton and A. A. Julien describe "The Singing Beach of Manchester, Mass.," noticing in the course of the paper the sonorous sand in the Island of Eigg (Hebrides), as well as others on record. It results from their observations that the sound is due to the grains, which are not rounded, but have flat and angular surfaces. It is, we think, undoubtedly a vibration phenomenon. We are acquainted (probably the fact is common) with a small screw-tap in a lavatory, which is loudly sonorous when a certain amount of water is allowed to issue, but silent in other positions. Prof. W. J. Beal, in addressing the Section of Biology, deals with "Agriculture, its Needs and Opportunities;" and the Section received a considerable number of interesting communications. Dr. Franklin B. Hough addressed the Economic Section on the method of statistics, and the address of Mr. E. B. Elliott, delivered to the same Section at the preceding Montreal meeting, is printed in this volume. This Section does not appear to receive nearly so many communications as the corresponding one of the British Association. The address of Prof. O. T. Mason to the Section of Anthropology deals with the scope and value of anthropological studies, and a considerable number of interesting papers were read. Those relating to mound-building may be of service to European archæologists as offering suggestions which may help in the interpretation of some of the earthworks in the Old World.

LETTERS TO THE EDITOR

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

On the Terminology of the Mathematical Theory of Elasticity

THE late Dr. Todhunter left, in an incomplete state, a valuable "History of the Mathematical Theories of Elasticity,"

which the syndics of the Cambridge University Press have intrusted to me to complete and edit. In reading the great number of memoirs relating to the subject I have been much struck by the want of a clear and accurate terminology in both theoretical and practical elasticity. I have been forced to the conclusion that the great discrepancy, which is often to be found between theoretical and practical results, is in some measure due to the want of this terminology (*e.g.* the extreme looseness of the term "limit of elasticity"). I find it needful for the purposes of the above work to adopt such a terminology, but before doing so it would be extremely valuable to have the opinion of some of our leading elasticians on the terms I venture to propose. I should be very glad of any suggestions, through the columns of NATURE, towards a definite and uniform terminology.

I am particularly dissatisfied with the term "limit of superimposition." It is exceedingly clumsy. Other possible terms are—"limit of superposable stress," "linear limit," and "limit of constant slope," the last two phrases having reference to the fact that the stress-strain curve at this limit ceases to be a straight line. With regard to this limit of superimposition I may remark that it may arise from one of two causes—(1) The strain components become so large that we cannot neglect the squares of small quantities, or the stress components can no longer be taken proportional to those of strain. This might happen before permanent set. (2) Permanent set may arise which does not follow the generalised Hooke's Law. This seems the more probable case, and has been adopted below. Prof. Kennedy tells me that he thinks when a body has been reduced to a state of ease that the superior elastic limit and the limit of superimposition coincide.

It has been proposed, I believe, to term that limit of stress at which bars begin locally to "thin down" the limit of viscosity. The "limit of uniform strain" is not altogether satisfactory or quite suggestive of this peculiar viscosity. "State of maximum stress" might perhaps serve the purpose, were one quite sure that this state always coincides with the viscous limit.

In the following remarks I have been much assisted by Prof. J. Thomson's epoch-making paper in the *Cambridge and Dublin Mathematical Journal* for 1848, and even more by Prof. Alex. B. W. Kennedy's paper on Riveted Joints in the *Proceedings* of the Institution of Mechanical Engineers, April, 1881 (especially pp. 208-213).

We have first to distinguish between two classes of materials. In the one we may suppose the particles to be in a state of internal stress before any external force is applied; in this case any, the least, external stress will probably produce permanent set. If this stress be removed and then reapplied, after one or two trials it will cease to produce permanent set, or at least the permanent set will be extremely small as compared with the elastic strain. We thus need a term to mark that state of the body when external stress does not produce permanent set owing to the existence of internal stress. This might perhaps be termed the *state of ease*. Many discordant results with regard to the constants of elasticity are not improbably due to the fact that the ratio of stress to strain has been measured before the material has been reduced to a *state of ease*. In the second class of materials we may suppose this state of ease to exist before the application of any stress. Supposing a body to be in its state of ease, there will then exist two limits, one on one side, and one on the other of the unstrained shape, which may be termed the *inferior and the superior limits of perfect elasticity*. Any external stress which does not produce a strain exceeding these limits will not give rise to permanent set. These inferior and superior limits of perfect elasticity mark, as a rule, the range covered by the usual mathematical theory. Within these limits it is generally safe to assume that the components of internal stress are proportional to the components of strain. In some cases, *i.e.* cast iron, where, however, it is difficult to produce the state of ease, this does not seem to be accurate—the stress and strain components appear never to be proportional.

In most materials the range of perfect elasticity is not large. An external stress, which is by no means nearly equal to that which is required to produce rupture will give rise to a permanent set. Thus permanent set in some materials will commence at a stress only ⅓ to ½ of the stress that those materials are capable of standing. Thus beyond the limit of elasticity we have first a range of stresses, which produce strains partly elastic and partly permanent. The strain in this range might still remain proportional to the stress; the permanent is yet small as compared with the elastic part of the strain. This range is bounded, however, by a stress for which the strain ceases to be proportional to the stress. In other words, the "generalised" Hooke's law is no longer applicable. Up to this point, if we are merely desirous of finding the strain produced by any system of statical stress, the mathematical equations of elasticity will apply, supposing, as seems probable, that the elastic constants do not alter, owing to the permanent set. Those equations would not of course be valid if we wished to find the strain in the body, if the stress were altered, nor would they suffice to treat vibratory motions capable of producing permanent set. This limit, which is that at which the *ut tensio sic vis* principle ceases, requires a name. It might perhaps be termed the *limit of superimposition*. That is to say, if a certain addition to this limiting stress produced a certain increase of strain, and a second addition another increase, these increments of stress, if superimposed would not produce the sum of the strain increments. It might at first sight appear more direct to term it the modular limit, or the limit of Hooke's law, but it would seem that, after this limit is passed, Hooke's law, probably with the same modulus, applies to so much of the strain as is elastic strain; in fact at the limit of superimposition it is the permanent set part of the strain which ceases to obey Hooke's law. In some materials the limits of perfect elasticity and of superimposition may coincide. At the latter limit the permanent set is still in some cases only one-twenty-fifth of the total strain. Neither of the limits above considered is *commercially* treated as the limit of elasticity. This is the point at which the material "breaks down," that is to say, the stress being continually increased, a strain is obtained which would be preserved by replacing the stress by one very much less. The material is unable to balance the stress upon it. If the stress be maintained the strain will suddenly increase by a considerable amount (without the stress being increased). This remarkable limit, it has been suggested by Mr. Tweddell, should be termed the *limit of fatigue*. The limit of fatigue being past, a small proportion of the strain, namely, so much as corresponds to the modulus, is elastic, the greater part is permanent set.

In the case of bars of iron subjected to longitudinal pull, if the stress be increased beyond the limit of fatigue, another limiting strain is reached, namely, one at which local contraction begins, or the bar commences to draw out at some point, *i.e.* the strain ceases to be uniform. The material now begins to act as if it were "viscous," and it would be convenient to describe this state as that of *viscosity*, had not this name been appropriated to that permanent set which may be produced by the application for a long period of a stress well within the limits of perfect elasticity. Closely associated, if not the same, with this *limit of uniform strain* is the state of maximum load. From this point onwards, as the strain increases the load decreases, till the breaking load is reached with a magnitude below that of the maximum load. To distinguish one from the other requires a special manipulation. As a rule, what is meant by the *absolute or breaking strength* is probably the *maximum load*, for if this load was allowed to remain, the bar would break under it. It might perhaps be convenient, however, to speak of one as the *maximum* and the other as the *terminal load*. With the terminal load the "elastic life" of the material is concluded. It must be remembered that owing to the bar locally thinning down, the stress per unit area at the terminal load is greater than the stress per unit area at the maximum load.

Such are the limits for which it is needful that a terminology should be established. I shall be extremely glad if any of the readers of NATURE, who happen to be elasticians, will suggest a more concise phraseology. KARL PEARSON

University College, February 14

Civilisation and Eyesight

I HAVE been interested in Lord Rayleigh's note on "Vision," and would offer my mite on the subject.

I have no doubt that brilliancy of image and power of distinguishing largely depend on definition. The brilliancy does so for the same reason as that which induces an artist to heighten colour-effects by sharp contrasts. In the same way, if we seek to decide if two colours are alike, we place them in immediate contact with a sharp edge. Details are best seen with a telescope when the images are sharp and untroubled. When slight tremors are in the air, and the image is rapidly displaced in all directions, so that what we see is the resultant

of many rapidly succeeding impressions, then tints are graded into one another at the edges, and we lose the power of distinguishing detail.

I can give, fortunately, a case in point. My eyes are affected with a small amount of astigmatism. It does not affect general vision for ordinary purposes, nor, of course, the definition of single lines; but, when I use appropriate lenses, the whole scene becomes brighter and more cheerful, and I see details. The bark of a tree is a perfectly different object with and without them. With them it is like a good photograph; without them, like many pictures. Formerly, in addition to the cylindrical surface, I required a slight spherical concave, and I was disposed to place the increased general brilliancy of the view mainly to the reduction of size, but I now use plano-cylindrical lenses for distant vision, and it is evident that the brilliancy is solely due to the better definition.

I would, lastly, suggest for Lord Rayleigh's consideration the question whether the change of focus of his eyes in faint light is not partly, at all events, due to change in the colour of the light. I know that there is such a change with me, but I have long had reason to believe that colour affects my vision.

J. F. TENNANT

37, Hamilton Road, Ealing, W., February 7

THOSE who have compared Lord Rayleigh's letter in NATURE of February 12 with that of Mr. Brudenell Carter on February 26 will have observed an inconsistency occasioned by a slip of the pen.

The latter says: "The commonly accepted standard of normal vision is satisfied by deciphering letters the parts of which subtend visual angles of one minute. . . ." Also, Prof. McKendrick states that "The smallest visual angle in which two distinct points may be observed is 60 seconds."

According to Lord Rayleigh, however, "A double star cannot be fairly resolved unless its components subtend an angle exceeding that subtended by the wave-length of light at a distance equal to the aperture. If we take the aperture of the eye as 1/5th inch, and the wave-length of light as 1/40,000th inch, this angle is found to be about two minutes." In the case of a small angle the aperture divided by the distance is approximately equal to the arc divided by the radius or to the circular measure of the angle. Hence in the present case we have $\frac{1/40{,}000\text{th inch}}{1/5\text{th inch}} = \frac{1}{8000}$ radian or $\frac{206{,}265}{8000} = 25{\cdot}8$ seconds nearly, instead of the two minutes accidentally stated by Lord Rayleigh.

This minimum value seems to show some mistake in Ehrenberg's experiments on vision, and is about half of that found by Helmholtz for the best of twelve observers.

March 10 SYDNEY LUPTON

[Mr. Lupton is quite right. By a stupid blunder I said about two minutes, when I should have said about half a minute.—RAYLEIGH.]

THERE is a defect of eyesight common among the natives of India known as "rātandhī," *lit.* "night blindness." Persons affected with this have either ordinary powers of vision by daylight, or else powers so little less than ordinary as to feel no inconvenience, so that usually no defect is noticeable; whilst in feeble twilight their sight fails in the most extraordinary way, and in the dusk they become (in bad cases) practically blind. Of course there are all degrees of this affection; but the strongly-marked cases alone are likely to attract attention.

By medical men in India this affection is said to occur most among men living on a low diet (chiefly of cereals), and the usual palliative treatment is to prescribe a meat diet.

This affection is rarely noticeable among Europeans in India, though I have sometimes noticed marked differences of clearness of sight among them also amounting to slight "night-blindness." Lord Rayleigh's case of short-sightedness in twilight and in the dusk seems to be a mild case of this sort (see NATURE, February 12, p. 340).

ALLAN CUNNINGHAM

The Pupil of the Eyes during Emotion

ALTHOUGH further observations are required, there seems to be a more or less general assent as to the influence of the emotions on the pupils of the eyes. Mr. Clark, in his letter to your journal (vol. xxxi. p. 433), has rightly quoted Gratiolet, who says that in sudden astonishment or fear the whole system becomes paralysed, and at the same time the pupils dilated. In anger, on the other hand, when the whole body is roused into action, the pupils become contracted: "Les pupilles sont énormément dilatées dans l'épouvanté, tandis qu'elles sont toujours contractées dans le colère." This was, however, said many years before by the celebrated Harvey, who, in his discourse on the circulation of the blood, written in 1628, says: "In anger the eyes are fiery, and the pupils contracted" ("Irâ rubent oculi, constringitur pupilla").

I should myself think that a narrow pupil evinces a more active mental state, as it is this condition which is present when the eye is accommodated to regard with attention a near object, whilst, on the other hand, when gazing out into distance, the pupils are wider, and the mental mood is more passive and contemplative.

In my parrot the size of the pupil is a very excellent measure of its frame of mind. When angry the pupil becomes minutely contracted, whereas when the bird is sympathetic and amiable the pupils become as widely dilated. Balzac, with other novelists, have depicted the state of the pupils when describing the various emotions and passions. The former in pourtraying a saintly woman kneeling before the altar, says: "The pupil of the eye, endued with great contractility, appeared then to expand and draw back the blue of the iris until it formed no more than a narrow circle. What force was that arising in the depths of the soul which so enlarged the pupils in full daylight and obscured the azure of those celestial eyes?" Darwin speaks doubtfully, but rightly demands more observations on the subject.

SAMUEL WILKS

Grosvenor Street, March

Auroræ

AFTER a long and remarkable absence of aurora, which, from a letter in your columns of February 19 (p. 360) does not appear to have been confined to these more southerly latitudes, we were favoured last evening with a beautiful, though somewhat transient display. It was about 9·25 p.m. when I first noticed a long band or belt of light above the northern horizon. At first it was ill-defined, with little change of position, but in about twenty minutes it became more luminous and the characteristic streamers suddenly made their appearance, shooting upwards, sometimes from above, sometimes from below the belt of light, which for a few seconds changed into a double arch. Some of these streamers rose as distinct columns, showing the usual prismatic hues, one in particular being noticeable as traversing the inverted W of Cassiopeia, another forming a fan-like terminus to the luminous region, but all confined to a low altitude, bounded on the north-west by Perseus, and on the north-east by Vega, then rising. It may be well to observe that on the same day (the 15th) a large sun-spot had just reached the central meridian, and was beginning to show signs of great disturbance.

E. BROWN

Further Barton, Cirencester, March 16

Injuries caused by Lightning in Venezuela

IN answer to Mr. von Danckelman's inquiry as to the use of lightning-rods and the frequency of accidents from lightning in the tropics (NATURE, December 11, 1884, p. 127), I beg leave to offer the following information referring to Venezuela, where I have been residing ever since 1862:—

Thunderstorms are very frequent during the rainy season. They break out generally in the afternoon, about the time of the daily maximum of heat, whilst they are extremely rare in the morning (I only witnessed one case) and during the night. Statistics of accidents do not exist, nor are there many lightning-rods in use (in Caracas about half a dozen). But there are certain regions where the former are far from being uncommon, as, for instance, the country around the Lake of Valencia and the plains or *llanos* to the north of the Orinoco. In these a considerable number of cattle are killed by lightning every year, and I know also of several cases where houses were destroyed and people killed. The herds of cattle crowd together as soon as a thunderstorm begins, and the animals remain during the whole time with their heads down to the ground, thus avoiding instinctively that their pointed horns should act as lightning-conductors.

In the neighbourhood of Maracay, at the eastern end of the Lake of Valencia, accidents occur almost every year. A very

remarkable one was witnessed in 1883 by Dr. Manuel A. Diez, at that time physician of the military camp at Maracay. A lightning struck a *rancho* (small country house built of wood and mud, and thatched with straw or large leaves), where a man slept in a hammock, another lay under the hammock on the ground, and three women were busy about the floor; there were also several hens and a pig. The man in the hammock did not receive any injury whatever, whilst the other four persons and the animals were killed. As the wooden framework of the house was probably very dry, the man in the hammock was almost isolated; but the other persons and the animals were in direct contact with the floor—in this case the bare ground.

Near Caracas accidents are comparatively rare. During all the years of my residence here no more than six have come to my knowledge: in three of them some damage was done to buildings, in two cases large trees were split, and in one (October, 1882) a ploughman was killed while at work in the field, together with his two oxen, his driving-stick (about four yards long, and shod with an iron point) having acted as lightning-conductor. A. ERNST

Caracas, February 8

Mira Ceti

WITH reference to your note on Mira Ceti in NATURE of February 5, I beg to say that I have observed Mira since December 15, 1884, and my observations show that the star reached a maximum on February 4, when I estimated it equal to α Ceti, or about 2·7 magnitude. It remained of the same brightness up to February 13, and has faded very slowly since that date. It was, last night, not much below α Ceti. J. E. GORE

Ballysodare, Co. Sligo, Ireland, March 8

Physical Geography of the Malayan Peninsula

I HOPE you will give me space in your journal to correct a few errors that have slipped into the letter under this heading in the issue of December 18 (p. 152) by the Rev. J. E. Tenison-Woods.

In the first place, there is no fluor-spar in the drift which carries the tin. The stone referred to is rose-quartz, some of which is very beautifully coloured. I have a specimen of it nearly as large as a man's head. It has a specific gravity of 2·63, and hardness equal to ordinary white quartz, which it will scratch without difficulty.

In the next paragraph Mr. Tenison-Woods says he cannot recall any mines on the eastern slopes of the mountains. This seems extraordinary, as some of the best mines in Kinta are on the eastern slopes of the valley, and I accompanied Mr. Tenison-Woods to the Lehat, Pasin, and Papan mining districts, and, with the exception of the Kwala, Diepang, and Gopeng mines, these were the only ones visited by him in Kinta, which were not on the eastern slopes of the valley. Following out the same idea, he says, speaking of the Kinta valley, "The river flows, like the Perak, on the eastern side of the valley." This is also a mistake, for it is decidedly on the western side, and this accounts for the fact mentioned in the next line: "The eastern tributaries are many and important." If the rivers were as stated by the rev. gentleman, this would be nearly impossible. I have taken the opportunity of asking the opinion of the officer in charge of the Kinta district, and he coincides with my view of the position of the river.

The next point on which I cannot agree is that "there is not the slightest sign of any recent upheaval of the coast-line, while the evidence of subsidence is equally absent. A short time ago a boring was made to a depth of 75 feet at Matang (which is the port of Larut), and I made a section from it, which shows that, within quite recent times, an important alteration of level has taken place. The ground at that place is 6 feet above the present high-water mark. Down to a depth of 17 feet from the surface the formation is marine, but below that, beds of sands, clays, and gravels, with leaf-bands and pieces of wood, are met with, of the same nature as the drift near the hills, and containing a small quantity of fine tin; these beds extend down to a depth of 75 feet, and most probably much further. It therefore appears that there has been a subsidence of at least 75 feet since the formation of the tin-bearing drift of Larut. An alteration of level of this extent must have made most important geographical changes in the Straits of Malacca, and may help to solve many of the problems connected with the distribution of the flora and fauna of this interesting locality.

The limestone-hill on the eastern side of the Gapis Pass, called Gunong Pondok, is 1800 feet in height, instead of 400 feet, as stated; and is connected by a ridge with the main range of mountains. A little further on Mr. Tenison Woods says that there are *two* mountains called Gunong Hijau. This is a very excusable mistake for a stranger to make, for one is Hijau, which means "green," and the one further to the north is Ijoh, which is the name of a palm (*Arenga saccharifera*). The Kurau river has its source on the former mountain, at the back of the town of Thaipeng. About four years ago I followed the stream from near the summit of Hijau down to the plains. L. WRAY, Jun.

Perak Museum, Larut, Perak, January 30

The Continuity of Protoplasm in Plant Tissue

THERE is some danger that those who are unable to make a personal examination of the Florideæ may be a little misled by Mr. Gardiner's remarks thereon in his article on "The Continuity of the Protoplasm in Plant Tissue" (NATURE, vol. xxxi. p. 390). In arguing in support of his own view that this continuity is not direct, but indirect he states that "Schmitz has found that a pit-closing membrane," "perforated in a sieve-like manner," exists in the Florideæ, and that he himself has "been able to confirm Schmitz's results as to the existence of the closing membrane in question."

Now, if Mr. Gardiner means by this that what he terms a pit-closing membrane, perforated in a sieve-like manner, is present in *all* the Florideæ, or even in *all parts* of the thallus of a single species, I venture to submit that the statement is not in strict accordance with fact. In my investigations into the histology of these plants, special attention was paid to this point, and by no methods that I could devise, or learn from other workers, was such a membrane to be demonstrated in the simpler forms, as, for example, in *Petrocelis cruenta*. Indeed, I cannot conceive how a sieve-plate arrangement could possibly exist, where the continuity is maintained by *a single thread of protoplasm*, and that of such extreme tenuity as in the species referred to. So far as I am aware, no one maintains the existence of a sieve-plate in the threads of Volvox, and I fail to see why it should be assumed to exist in the equally fine threads now under consideration.

Further, in *Polysiphonia*, *Ptilota*, and other genera, where a membrane is normally present, it is *not* met with *in every part* of the thallus, being absent from the younger portions. In these portions the connecting threads are *single* and *extremely delicate*, so that while observation affords no indication of a sieve-plate, the arrangements themselves preclude the possibility of one. As the threads grow older and thicker, a membrane which may be perforated is developed, but it is no part of the primary wall of the protoplast. Thus, while the connecting protoplasmic threads exist from the first, the so-called pit-closing membrane arises as *a later development*, and is therefore *subsidiary to the continuity*, and *not essential* to it.

So far, then, as the Florideæ are concerned, I think we must recognise two conditions or stages of continuity; first, a direct continuity, permanent in the simpler forms, but transitory in the more complex ones; and second, an indirect continuity, absent from the younger, but present in the older tissues.

Harrogate, March 7 THOMAS HICK

Time in the United States

IN your issue of January 23 the statement (p. 277) that "local time throughout the United States, as opposed to railway time, has been abolished," is not quite accurate. At the introduction of the "standard" time an attempt was made in many places to do this, but it has proved impracticable, except near the meridians of time. At other places the local time still governs all the daily business, except what involves travelling. For this the difference, a constant quantity, is remembered, and the proper allowance made. For example, here we allow thirty-three minutes, being west of the meridian of eastern time to that amount. E. W. CLAYPOLE

Akron, Ohio

FACILITIES FOR BOTANICAL RESEARCH

THE botanical student who has successfully passed his final examination at one of our universities or local colleges will naturally begin to consider to what use he can devote the knowledge of facts and methods which he has acquired. To many it is unfortunately necessary to turn at once to some employment which will bring in a substantial return. Teaching pays; research does not; so the latter is often out of the question. But the few to whom earning money is not an immediate necessity hardly realise the splendid possibilities which lie before them. Of these men of more or less independent means some, from pure inertness, may be content to move within the narrow circle of their own university; others, following the example of their predecessors, will start on the German pilgrimage and sit at the feet of one or other of those teachers whose names they have long venerated from a distance. The advantage of working under the direction of one of these masters is no doubt very great, but still Germany lies in the temperate zone; the flora approximates nearly to that of Great Britain, and the gardens and hot-houses are in no way superior to our own. It rarely enters into the calculations of a young graduate that a journey to the tropics is a possible alternative to the German pilgrimage; yet a circular recently issued by Dr. Treub, the well-known Director of the Botanical Garden at Buitenzorg, in Java, shows us that a visit of six months to the island is well within the range of any man who has 200*l*. to spend upon it. It is true that this expense is decidedly greater than that of living for six months in a German University town, but the advantages are correspondingly greater. In the first place, a tropical vegetation offers ample opportunities for research, especially in the branches of morphology and anatomy: in proof of this it is sufficient to turn over the pages of the *Annales du Jardin botanique de Buitenzorg*, and note the valuable results there detailed, chiefly from the pen of Dr. Treub himself; secondly, the Government of the Dutch Indies has recently placed suitable buildings at the disposal of the Director, who finds that he now has accommodation in his laboratory for four foreign investigators to work simultaneously; again, in the person of Dr. Treub, who, it may be mentioned, is a proficient in the English language, there is constantly present at Buitenzorg one of the first investigators of our time. In his circular Dr. Treub combats the idea which most of us would probably entertain, that Buitenzorg, being in the tropics, is necessarily unhealthy: he states that, though he will not pretend that a stranger coming to stay for four or five months cannot possibly fall ill, still the chances of contracting disease during that time are not notably greater than if one stayed at home or travelled on the continent of Europe. He recommends the period between October and April as the best, both as regards health, comfort, and the vegetation. Here is an opportunity the like of which has perhaps never before been offered to students, and one which can best be embraced by those who have not yet assumed the yoke of regular employment.

These facilities for botanical research in a tropical climate, thus offered freely to strangers by the Dutch, naturally suggest to the English mind that with all our colonies we have at present little of a like nature to offer: we have in our gardens at Calcutta and Peradeniya as good chances of establishing laboratories for botanical research as the Dutch had at Buitenzorg Prof. Haeckel's interesting account of his recent tour in Ceylon, and of his visit to Peradeniya, gives some idea of the scope there would be for a young botanist to carry on morphological and anatomical work In the sphere of thallophytic botany Mr. H. M. Ward has already shown that a lengthened stay in the tropics may lead to the attainment of very valuable results.

But without going so far afield as the tropics, and at a decidedly less cost than such a journey would entail, plenty of scope may be found for satisfying the desire to investigate. Thus at the well-known marine biological station at Naples, the tables which are habitually occupied by zoologists might well be applied for by botanists: the numerous botanical memoirs issued from this institution by continental observers show that the institute of Dr. Dohrn is well adapted for the investigation of marine algæ as well as of marine animals.

A second marine station, devoted more particularly to the study of botany, is that at Antibes, now in the possession of the French Government; it was formerly the private residence of M. Thuret, to whose researches, in conjunction with M. Bornet, we owe so much of our knowledge of the reproductive processes of marine algæ. Being compelled, for the sake of his health, to pass the winter months in the south, M. Gustave Thuret chose the beautiful promontory of Antibes for his residence. He laid out the grounds surrounding his villa as a winter garden, collecting together many rare and beautiful plants; at the same time, while attending to the collection and correct identification of terrestrial forms, he availed himself of the opportunity presented by residence on the coast to apply himself with vigour to those researches on marine algæ with which his name will always be connected. On his death in 1875, Mdme. Henri Thuret, desiring that the valuable collections of her brother-in-law should not be dispersed, bought the property for a sum of 200,000 francs, and presented it to the nation, the State undertaking the expenses of its maintenance. M. Naudin was appointed as director of the new institution. It is understood that on suitable application being made, foreigners can obtain admission to the laboratories of the Villa Thuret, which offer exceptional opportunities for the study both of marine and terrestrial forms.

However great the advantage may be of visiting countries of a climate different from our own, it is far from being necessary for an English student to leave his own country in order to satisfy his desire for research: the methods in use in the botanical laboratory are now taught with precision in our Universities: any student who has passed his final examination in the first class should be in a position to conduct a research successfully, if he has in him the necessary mental qualities. To such a man the resources of the Royal Gardens at Kew are a real mine which shows no sign of exhaustion. Not only may an investigator obtain access to the unrivalled collections, both living and dry, of the Royal Gardens, but, since Kew is in constant communication with distant countries, materials for completing a research may often be obtained which could scarcely be accessible in any other way. Through the munificence of the late Mr. Jodrell, a well-appointed laboratory has been erected in the Gardens, with the express object of encouraging research.

Lastly, it must be admitted that the poverty of our efforts in recent years to investigate the marine algæ of our coasts is little short of a disgrace to us as a maritime nation. Even our commonest sea-weeds are so little understood that they would well repay a careful investigation. Work on the sea-coast must for the present depend upon individual enterprise; but we may hope that shortly, when the Marine Biological Association has a fixed abode, botanists may be found ready to make a proper use of the opportunities which they will then enjoy.

In view of the constantly increasing bulk of botanical publications, which may be taken as an index of a steady increase in activity of research, it may be thought that it is more difficult at the present day to strike out an original line than at earlier periods in the development of the science. But, against this great increase of our

knowledge we must set the more systematic training to which students are subjected before they are expected to take an independent line; secondly, the new methods of treatment and new points of view which now succeed one another more rapidly than at any previous time; and, thirdly, the very greatly increased facilities for research on the spot in foreign countries. When it is remembered how many of our most prominent men started their careers as travellers, the importance of the third of the above considerations will be valued as it ought to be. Those who are best able to appreciate the position of anatomical and physiological botany would probably be the first to agree that the opportunities for research in these branches, either in foreign lands or at home, are, at the present moment, better than they have been at any former period in the history of the science. If the botanical students of the present day content themselves with devoting their time and energy to working out small and uninteresting details, it is their own poverty of imagination and want of enterprise that are to blame. F. O. B.

MOLECULAR DYNAMICS[1]

I HAVE placed the three titles above this article not because I intend to deal with more than the last, but because they all deal with the same matter, and show how much the author's attention was directed to the subject during his three months' sojourn in America. The audience at the Baltimore lectures consisted chiefly of American professors, and a few English men of science attended a larger or smaller number of the lectures.

Speculation was rife as to the probable character of the lectures, and there was a general feeling that vortex motion would be largely dealt with. This, however, was not so. The course of twenty lectures was confined to the wave theory of light, largely dealing with the difficulties of that theory. The published lectures are not printed, but "jelligraphed," as Sir William Thomson would say. The number of copies is extremely limited, and are of unique interest, being reproduced from the short-hand notes taken at the lectures. Every one who knows how suggestive Sir William's lectures are and how fertile his mind is in bringing illustrative digressions to bear on the topic in hand, will expect these verbatim notes to be a rare treasure. Nor will he be disappointed. Mr. Hathaway, the reporter, has the unusual combination of being an expert stenographist, a skilful mathematician, and a clear and distinct caligraphist. His notes contain numerous errors, such as are unavoidable in such an undertaking, but, viewed as a whole, his work is almost a marvel.

The lectures treated of three branches of the subject: (1) the propagation of a disturbance through an elastic medium; (2) the character of molecular vibration; and (3) the influence of molecules on the propagation of waves. Each lecture generally dealt with two of these branches, and between the two parts of the lecture Sir William went among his andience and had some conversation with them. It was ever his object to discard the professorial attitude and give his lectures the aspect of conferences. Discussion did not end in the lecture-room, and the three weeks at Baltimore were like one long conference guided by the master mind. It is not surprising that at the end of that time there was a genuine feeling of sadness at parting on the part of teacher and taught alike.

The part of the lectures dealing with the propagation of an elastic disturbance could not be expected to contain much novelty, but it was treated in so novel a manner and from so purely a physical point of view, that it could not but be instructive. Many of the old supporters of the theory dealt with it purely from a mathematical point of view. They treated the problem as a mathematical exercise, and did not hesitate to make unwarranted assumptions to produce pretty formulas or simple solutions. Even such men as Weber (in his "Theory of Magnetism") and Green (in his "Wave Theory") have been guilty of this practice. Sir William Thomson never made any but physical assumptions, and these were made for reasons given. Rather than make a meaningless mathematical assumption he would prefer to burden his formulas with undetermined quantities, and even, if unable to reach the final solution, would rejoice in the richness of the formulas, which showed a potentiality of overcoming many difficulties. He does not always commend Rankine's mathematics, but he says this for him at p. 185: "Rankine did a great deal to cure the mathematical disease of *asphasia* from which we suffered so long. Faraday did most. The old mathematicians used neither diagrams to help people to understand their work, nor words to express their ideas. It was formulas, and formulas alone. Faraday was a great reformer in that respect with his language of 'lines of force,' &c. Rankine was splendid in his vigour and in the grandeur of his Greek derivations." This refers to Rankine's nomenclature of different kinds of moduluses and their reciprocals—*e.g. plagiotatic*, *thlipsinomic*, &c.

The first lecture is a summary of what is to come, and is partly historical. The difficulties in the way of accepting the wave theory of light are clearly pointed out. These are four in number.

First Difficulty: Dispersion.—The difficulty is to explain how velocity of propagation depends on period of vibration. Two explanations have been offered, that of Cauchy and that of Helmholtz. He does not delay much with Cauchy, who ascribed it to heterogeneousness. He prefers Helmholtz, who ascribes it to a compound structure of material molecules, which gives them a natural period of vibration. The one explanation has relation to wave-length, the other to period of vibration. The latter, he thinks, falls in better with results of spectrum analysis, &c. A great portion of the lectures is devoted to expanding the notion of Helmholtz. The space occupied by a molecule must be filled with a substance differing from the ether either in rigidity or in density, or both. Lord Rayleigh has taken in hand this question in his researches on blue sky, and it seems that a variation of density is the principal or only effective cause. With respect to the new (Helmholtz-Thomson) spring and shell molecule, he says, "It seems to me that there must be something in this, that this, as a symbol, is certainly not an hypothesis, but a certainty."

Second Difficulty: the Ether.—He makes short work of the difficulty of reconciling almost perfect rigidity with almost perfect mobility. It is merely a matter of time. You can make a tuning-fork of Burgundy pitch when the period is a small fraction of a second, but a bullet will pass clean through several inches of it in six months. The ether may be highly elastic for vibrations executed in the 100 or 1600 million millionth of a second, but highly mobile to bodies going through it at the rate of twenty miles a second.

Third Difficulty: Refraction and Reflection.—Theoretical equations agree qualitatively with facts, but there are serious discordances when we come to quantitative measurements. Especially is this the case in the completeness of extinction of the ray polarised by reflection.

Fourth Difficulty: Double Refraction.—It is found that when the medium is displaced during wave-propagation in a double refracting crystal, the return force must depend on the direction of vibration, not on the plane of distortion, as all elastic theories indicate. Rankine and

[1] "On Molecules," the Presidential Address to Section A of the British Association, August, 1881, by Sir William Thomson.
"The Wave Theory of Light," a Lecture delivered by Sir William Thomson at Philadelphia on Sept. 29, 1884, published in NATURE, vol. xxxi. p. 91.
"Lectures on Molecular Dynamics," by Sir William Thomson, Johns Hopkins University, October, 1884.

Rayleigh independently invented unequally loaded molecules which overcome the difficulty, but give a wave surface different from Huyghens', and Stokes has proved experimentally that Huyghens' construction is very accurate. Hence this way of escape is denied to us.

In treating of the propagation of waves in an isotropic (and later in an aeolotropic) medium, methods of Thomson and Tait's Natural Philosophy, and his own article, "Elasticity," in the "Encyclopædia Britannica," are used; $a\,b\,c$ are distortions about Ox, Oy, and Oz, $e\,f\,g$ are dilatations along Ox, Oy, Oz. The equation of the energy E is a quadratic in $a\,b\,c\,e\,f\,g$, containing twenty-one coefficients, some of which are annulled by isotropy.

If

$$P = \frac{dE}{de},\ Q = \frac{dE}{df},\ R = \frac{dg}{dE};$$
$$S = \frac{dE}{da},\ T = \frac{dE}{db},\ U = \frac{dE}{dc},$$

and if ρ be the density, and ξ a displacement along Ox, we obtain the equation

$$\rho\frac{d^2\xi}{dt^2} = \frac{dP}{dx} + \frac{dU}{dy} + \frac{dT}{dz}.$$

Moreover, if n be the rigidity modulus, k the bulk modulus, δ the cubic dilatation, and $m = k + \frac{1}{3}n$, we have

$$P = (m - n)\,\delta,$$
$$T = n\left(\frac{d\xi}{dz} + \frac{d\zeta}{dx}\right),$$

with similar expressions for Q, R, S, U.

Thence he shows that the equation

$$\rho\frac{d^2\xi}{dt^2} = m\frac{d\delta}{dx} + n\,\nabla^2\xi,$$

(with the condition $\frac{du}{dx} + \frac{dv}{dy} + \frac{dw}{dz} = O$ in an incompressible substance), contains every possible solution, and he proceeds to discuss special cases of the general solution which may be true of waves propagated by molecules through the ether. Here his desire for physical conceptions appears, and his hatred of mathematical *asphasia*. He considers the case of a ball moving to and fro, of a ball twisting about an axis, of a globe becoming alternately prolate and oblate, of a rod twisted in opposite directions at the two ends, and of the Thomson-Helmholtz molecule which is a heavy mass connected by massless springs with a massless inclosing shell, or there may be several shells inclosing each other, connected by springs with a dense mass in the centre (far more dense than the ether).

Here he discusses the manner in which a molecule may be supposed to give off its vibrations to the ether. Does it gradually increase in intensity and gradually die out, or how does it act? Here is what he says on this much-neglected point at p. 94:—

"The kind of thing that the luminous vibrator consists in seems to me to be a sudden initiation of a set of vibrations and a sequence of vibrations from that initiation which will naturally become of smaller and smaller amplitude. . . . Why a sudden start? Because I believe that the light of the natural flame or of the arc light or of any other known source of light must be the result of sudden shocks from a number of vibrators. Take the light obtained by striking two quartz pebbles together. You have all seen that. There is one of the very simplest sources of light. . . . What sort of a thing can the light be that proceeds from striking two quartz pebbles together? Under what circumstances can we conceive a group of waves of light to begin gradually and to end gradually? You know what takes place in the excitation of a fiddle-string or a tuning-fork by a bow. The vibrations gradually get up from zero to a maximum, and then, when you take the bow off, gradually subside. I cannot see anything like that in the source of light. On the contrary, it seems to me to be all shocks—a sudden beginning and gradual subsidence."

The light coming from a single shock is, of course, polarised always in the same direction. Sellmeier's deductions from Fizeau's experiment shows that there is no serious fading in 50,000 vibrations. Helmholtz introduces viscous terms which absorb the energy and might prevent the possibility of 50,000 vibrations from one shock. That is a retrograde step. Absorption can be explained without viscous terms.

Such speculations, when coming from one of less grasp of physical facts, would attract but little attention. But here all kinds of useful suggestions are continually thrown out for experiment and for hypotheses. He is striving to get at the physical meaning of radiation, absorption, anomalous dispersion, fluorescence, and phosphorescence, and here is what he says on some of these points at p. 90:—

"But there are cases in which we have that tremendous jangling, and that is in the fluorescence of such a thing as uranium glass, which lasts for several seconds after the exciting light is taken away, and then again in phosphorescence that lasts for hours and days. There have been exceedingly interesting beginnings in the way of experiments already made, but I think no one has found whether initial refraction is exactly the same as permanent refraction. For this purpose we might use Becquerel's phosphoroscope, or we might take such an appliance as Prof. Michaelson has been using for light, and get something enormously more searching than Becquerel's phosphoroscope, and try whether, in the first hundredth of a second, there is any indication of a different wave-velocity from that which you would have when white light passes continuously in the usual manner of refraction. If in the methods employed for ascertaining the velocity of light in a transparent body . . . we apply a test for an instantaneous refraction, I have no doubt we shall get negative results, but yet properties of ultimate importance. We might take bodies in which, like uranium glass, the phosphorescence lasts only a few seconds; and then, again, bodies in which phosphorescence lasts for minutes and hours. With some of these we should have anomalous dispersion, gradually fading away after a time. I should think that by experimenting, and so on, we should find some very interesting results of this kind."

In his mathematics he suppresses the condensational wave, and, in doing so, makes reference to the electromagnetic theory of light, which, he thinks, has added nothing to our physical conceptions of the ether. In treating, further on, of reflection and refraction, he speaks a great deal of the pressural wave, which many authors have called a condensational wave. I find that in some points my notes are fuller than the reporter's. I cannot find there the following characteristic passage about the pressural wave:—"People have tried to muddle this. The pressural wave has been the difficulty. Cauchy starved the animal, M'Cullagh and Neumann didn't know of its existence, Haughton put it in an Irish car and it wouldn't go, Green and Rayleigh treated it according to its merits."

With regard to the possibility of a condensational wave, and to the electro-magnetic theory of light, we find, on pp. 40-41:—

"We ignore this condensational wave in the theory of light. We are sure that its energy, at all events, if it is not null, is very small in comparison with the luminiferous vibrations we are dealing with. But to say that it is absolutely null would be an assumption we have no right to make. When we look through the little universe that we know, and think of the transmission of electrical force and of the transmission of magnetic force, and of the transmission of light, we have no right to assume that there is not something else that our philosophy does

not dream of. We have no right to assume that there may not be condensational vibration in the luminiferous ether. We only do know that any vibrations of this kind which are excited by the reflection and refraction of light are certainly of very small energy compared with the energy of the light from which they proceed. The fact of the case as regards reflection and refraction is this: that, unless the luminiferous ether is absolutely incompressible, the reflection and refraction of light must generally give rise to waves of condensation. Waves of distortion may exist without waves of condensation, but waves of distortion cannot be reflected at the boundary surface between two mediums without exciting in each medium a wave of condensation. When we come to the subject of reflection and refraction we shall see how to deal with these condensational waves, and find how easy it is to get quit of them by supposing the medium incompressible. But it is always to be kept in mind to be examined into: Are there or are there not very small amounts of condensational waves generated in reflection and refraction; and may, after all, the electric force not depend on the waves of condensation? Suppose that we have at any place in air, or in luminiferous ether, a body that, through some action we need not describe, but which is conceivable, is alternately positively and negatively electrified: may it not be that this will be the cause of condensational waves?" It is then supposed that two spherical conductors are connected to the terminals of an alternating dynamo machine, and the quotation proceeds:—

"It is perfectly certain, if we turn the machine slowly, that in the neighbourhood of the conductors we will have alternately positively and negatively electrified elements with reversals perhaps two or three hundred per second of time, without a gradual transition from negative through zero to positive, and the same thing all through space; and we can tell exactly what is the potential at each point. Now, does any one believe that, if that revolution was made fast enough, the electrostatic law would follow? Every one believes that, if that process be conducted fast enough several million times, or millions of million times per second, we should be far from fulfilling the electrostatic law in the electrification of the air in the neighbourhood. It is absolutely certain that such an action as that going on would give rise to electrical waves. Now it does seem probable to me that electrical waves are condensational waves in luminiferous ether, and probably it would be that the propagation of these waves would be enormously faster than the propagation of ordinary light waves. I am quite conscious, when speaking of this, of what has been done in the so-called electro-magnetic theory of light. I know the propagation of electric impulse along an insulated wire surrounded by gutta-percha, which I worked out myself about the year 1854, and in which I found a velocity comparable with the velocity of light. . . . That is a very different case from this, and I have waited in vain to see how we can get any justification of the way of putting it in the so-called electro-magnetic theory of light."

In those parts of the lectures which deal with wave propagation in an isotropic medium, by far the most interesting parts are those which treat of the conditions at bounding surfaces, whether these surfaces be reflecting and refracting surfaces or surfaces of radiating molecules, or surfaces of absorbing molecules. Lord Rayleigh's investigations and his own on the likelihood of the density or the rigidity of the substance composing a molecule differing from that of the ether are also full of interest

Much of this part of the subject has been thoroughly worked out before, but here the treatment is so original, the language is so suggestive, and I need hardly say that the whole course of lectures is so pregnant with useful ideas, that every one who reads this part will be well repaid.

Having now roughly indicated the novel points and the general mode of treatment of the problem in *molar* dynamics, I propose in the next notice to give some account of the problem in *molecular* dynamics, which occupied half of the time. GEORGE FORBES

(*To be continued.*)

THE LONG DURATIONS OF METEORIC RADIANT POINTS

IT is unfortunate that the observation of shooting stars is associated with difficulties of no common order. The very large number of distinct showers visible at the same epoch, their extremely attenuated character, and the many impediments to accurate determinations of the flights of the individual shooting stars proceeding from them, exercise an unfavourable influence on the work and deter many observers from grappling with a subject which is admittedly beset with such perplexing details. Apart from this, there exists the great necessity for observations to be sustained during the whole night, and this is rarely practicable either by amateur or professional astronomers, who generally have other important work in hand. In fact, meteoric astronomy requires the almost exclusive attention of the observer, and must be closely pursued for a long period of time if anything like comprehensive results are to be obtained. The voids occasioned either by moonlight or cloudy weather in a short series of observations are only to be filled up by prolonged watches extended over many consecutive years.

The long visible duration of a large number of radiant points of shooting stars is, it must be confessed, a fact which defies satisfactory explanation. The ingenious theory which had attributed to meteor streams an identity with cometary orbits, required that the visibility of such streams should be of very brief character, though in the case of an abnormally wide system or of a shower directed from a point near the earth's apex the duration might be longer than usual, but the radiant point could not maintain a perfectly fixed position amongst the stars. This general view of the subject is, however, not accordant with the results of recent observations, for while there are undoubtedly some cometary showers which display all the peculiarities taught by theory, there are many other streams which continue visible for several months and retain a stationary position in the firmament. It is evident therefore that these streams are presented to us under totally different circumstances as regards orbit to the true planetary showers, and are amenable to conditions and laws which form a problem the solution of which is arrested by no ordinary difficulties.

The multiplicity of streams would naturally originate a false appearance of long duration in certain radiant points, but observations of very precise character would soon show that the point of radiation, as successively determined, differed considerably, being not, in fact, confined absolutely to the same point in the sky. But it is now proved that there are no differences, other than those introduced by small unavoidable errors of observation, in the centres from which shooting stars continue to fall during several months. Indeed, it seems a probable inference from the observations that some showers exist all the year round, though not visible during the epoch when they are very near to the sun.

That such long enduring radiants of meteors can have a community of origin and belong to physically associated streams in the same degree as the true cometary meteor showers is very difficult to understand. But the fixity of the radiant over so long an interval would yet seem to indicate some bond of close affinity existing between them. At any rate we have no reason to suppose that a large number of showers, distinct in themselves, can occur consecutively from the same points of the sky owing to a common peculiarity of grouping.

At intervals of six months the earth's motion in space is in exactly opposite directions, and yet these streams of meteors enter the atmosphere from the same apparent radiants. Evidently therefore the meteoric particles, which individually move in parallel flights, are travelling independent of solar attraction and are presented to us under a totally different aspect to the cometary showers the phenomena of which are clearly understood.

If meteoric streams of great width are encountered by the earth as the result of the sun's proper motion in space then it would appear that to give the phenomena of stationary radiants they must move with enormous velocities. This is not borne out by the observations, for the meteors of these long-enduring streams exhibit appearances similar to what is generally observed in the meteors from the cometary showers. The farther the radiant is removed from the earth's apex the slower become the motions of the meteors, they lose the streak-generating capacity, and their colour changes from white to yellow or red, indicating a lower degree of incandescence as the result of a less violent friction with the atmosphere. There are exceptions, however, for the meteors from some radiants retain a velocity much greater than that theoretically assigned.

There is a very pressing need for further observations specially directed to the visible trajectories of shooting stars. The apparent motions of the corpuscles belonging to a stream depend upon several conditions which are very liable to originate discordances. The particles near the radiants move slowly in short courses owing to foreshortening, and when the radiant is near the horizon the flights are longer and more gradual than when it has reached a considerable altitude. The Geminids of December, for instance, appear very slow in the early hours of the evening, but in the morning their swift, diving courses would lead the observer to attribute them to an entirely separate family were it not that the radiant occupies an identical place to that determined

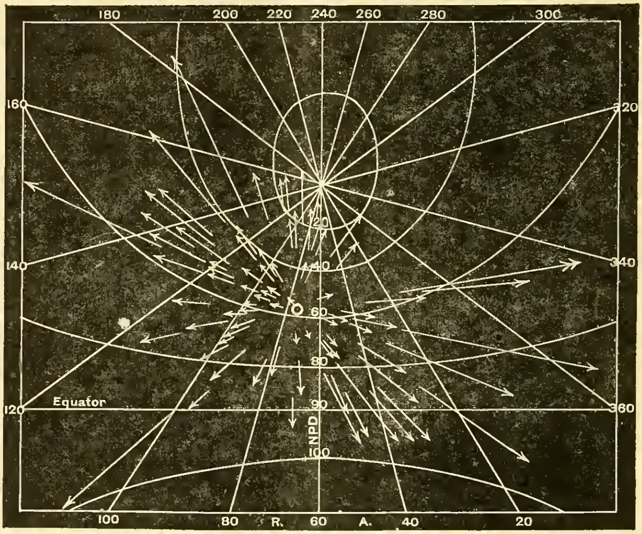


FIG. 1.

from the slower meteors recorded several hours before. Some showers also doubtless furnish meteors which become igneous at greater distances than others and more relatively slower than those belonging to streams formed of materials not so readily combustible. Moreover the specific gravity of the particles of different systems probably varies to some extent, and their individual forms may not always coincide, so that the effects of atmospheric resistance must necessarily introduce peculiarities in the observed flights.

The idea occurred to me that these long-enduring radiants must result from terrestrial meteor streams, *i.e.* streams revolving around the earth in an excentric orbit with perigee near the outer limits of the atmosphere. If streams of this character existed and were closing in upon the earth we should have the phenomena of stationary radiants. And the fact of their closing in upon us would be rendered possible on the assumption of a resisting medium (similar to that affecting the motion of Encke's comet), or that at each return to perigee the atoms encountered the tenuous outer region of the atmosphere, which, though not sufficiently dense to render them incandescent, would slightly diminish their velocity and thus bring about a contraction of the orbit. But there are difficulties to the adoption of such views, one of which is that the meteors from such streams would exhibit a consistency of velocity whatever the relative position of their radiants with regard to the earth's direction of motion, and this does not accord with the facts of observation.

The earth's atmosphere probably extends in a barely appreciable degree a much greater distance than ordinary estimates allow. The computed heights of certain meteors deduced from multiple observations, and the phenomena of minute, telescopic shooting stars, which are evidently far exterior to ordinary naked eye meteors, render this highly probable. The former are very numerous, though to what degree is only known to those who have been habitually engaged in sweeping the heavens with a telescope of low power and large field. According to my

own observations telescopic meteors exceed the more conspicuous class of these bodies in the proportion of about 40 to 1. Rich showers probably exist only visible with instrumental means, and certain showers readily perceptible to the naked eye afford little indication of their existence with telescopic aid. The Geminids may be ranked among the latter, for on December 12, 1877, Lewis Swift at Rochester, whilst comet seeking during a period of $4\frac{1}{2}$ hours, noticed a large number of naked eye meteors. They frequently intruded upon his attention in the intervals when his eye was withdrawn from the telescope, and his estimate of the number visible was 1000 for the whole period of his observations. Yet, singularly enough, there was an unusual paucity of telescopic meteors, only two certainly, and one other suspected, crossing the field of view of $1\frac{1}{2}°$, whereas they are usually of frequent occurrence.

The observation of meteors, both telescopic and otherwise, especially commends itself to amateurs as an attractive study, requiring no elaborate or expensive instruments. The inconveniences attending such work may soon in great measure be overcome by patience. In cases where the results are thoroughly reliable we think that even slender observations possess weight and ought to be encouraged, for such results soon accumulate, and if

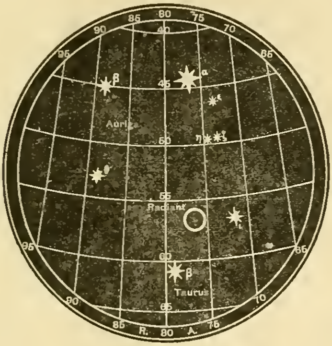


Fig. 2.

allowed to extend over several years may be combined and reduced to very satisfactory issues. Or the materials obtained by different observers for similar epochs might be collected and the radiant points determined from a careful analysis of the path-directions. In every instance, however, the physical appearances of the meteors ought to be fully described and given due weight in fixing the radiants. Without these precautions it is impossible to obtain reliable positions or to arrange the meteors into family groups with anything like that precision which is an essential feature of the work.

It is earnestly hoped that more enthusiasm may now be aroused amongst observers in this interesting department of astronomy. The question as to the duration of radiants and their absolutely fixed position must have an important bearing on the theory of their origin, and deserves much further investigation. The apparently intermittent character of many such streams also deserves notice, as their fluctuations may be regulated by definite periods of short duration. The observations of individual radiants should be confined to a few nights only, or when, from the paucity of meteors, it is found necessary to include results extending over several weeks, the nights of greatest intensity should be mentioned. The necessity exists for equal accuracy in deducing the radiant points, as in registering the exact directions of flight; in fact, great discrimination and precision are required in details so mutually dependent, so liable to errors, and so full of complications.

One of the most active and at the same time one of the most precise and well-defined cases of long duration is exhibited by a meteor shower in the southern extremity of Auriga and slightly to the north-east of a line connecting the stars ι Aurigæ and β Tauri. It gives the first sign of its existence at the end of July, and thence continues during several ensuing months. The epochs about October 8–15 and November 7 and 20 would appear to represent the most prominent exhibition of this radiant, though there are many other nights during the summer and autumnal months when it may be detected during a prolonged watch. The accompanying diagram (Fig. 1) shows the projected paths of eighty meteors (chiefly observed by myself at Bristol, and selected as being tolerably near the radiant point) recorded during the months of October and November. These paths form only a proportion of the aggregate number seen, but they sufficiently display the singularly precise radiation of this stream. A similar diagram might readily be prepared from the flights recorded in August and September when the convergence of an almost equal number of meteors attest the visibility of the same radiant. Its position relatively to the stars is given in Fig. 2, and it is hoped that observers will endeavour to effect its re-observation. We require further observations particularly during the month of August, when the radiant is very low, until the morning hours, and this doubtless accounts for the rareness of its apparition at that epoch. W. F. Denning

NOTES

Those who are interested in the South Kensington Museum will be glad to learn that the National Collections belonging to the Science Department have now a prospect of improvement. A Government Committee has lately been appointed to report generally upon them and to consider plans for properly housing them. The Committee consists of gentlemen of high position in various Government Departments; the Chairman is Sir Frederick Bramwell, F.R.S., and Dr. W. Pole, F.R.S., is the Secretary.

The Prince of Wales, President of the International Inventions Exhibition, has fixed Monday, May 4, for the opening of the Exhibition. Rapid progress is being made in all branches connected with the Exhibition. The large space set apart for machinery in motion is already being filled, whilst preparations for receiving other exhibits are well forward, some of which have arrived at the building. The Aquarium Department is receiving considerable attention, and will form a very attractive feature. The tanks have been thoroughly cleansed and refilled with fresh water, which has been softened and filtered, rendering it bright and pure, fit for the reception of large consignments of fish that will shortly arrive. Lord Onslow has lately presented 1500 exceedingly fine carp to the Aquarium, and a large number of fish indigenous to the Canadian Lakes have also been received for exhibition in the tanks.

The Royal Society of New South Wales offers its medal and a money prize for the best communication (provided it be of sufficient merit) containing the results of original research or observation upon each of the following subjects:—Series IV. To be sent in not later than May 1, 1885:—No. 13. Anatomy and life-history of the Echidna and Platypus; the Society's Medal and 25*l.* 14. Anatomy and life-history of Mollusca peculiar to Australia; the Society's Medal and 25*l.* 15. The chemical composition of the products from the so-called Kerosene Shale of New South Wales; the Society's Medal and 25*l.* Series V. To be sent in not later than May 1, 1886:—No. 16. On the chemistry of the Australian gums and resins; the

Society's Medal and 25*l*. 17. On the tin deposits of New South Wales; the Society's Medal and 25*l*. 18. On the iron-ore deposits of New South Wales; the Society's Medal and 25*l*. 19. List of the marine fauna of Port Jackson, with descriptive notes—as to habits, distribution, &c.; the Society's Medal and 25*l*. Series VI. To be sent in not later than May 1, 1887:—No. 20. On the silver-ore deposits of New South Wales; the Society's Medal and 25*l*. 21. Origin and mode of occurrence of gold-bearing veins and of the associated minerals; the Society's Medal and 25*l*. 22. Influence of the Australian climate in producing modifications of diseases; the Society's Medal and 25*l*. 23. On the Infusoria peculiar to Australia; the Society's Medal and 25*l*. The competition is in no way confined to members of the Society nor to residents in Australia, but is open to all without any restriction whatever, excepting that a prize will not be awarded to a member of the Council for the time being; neither will an award be made for a mere compilation, however meritorious in its way—the communication, to be successful, must be either wholly or in part the result of original observation or research on the part of the contributor. The successful papers will be published in the Society's annual volume. Fifty reprint copies will be furnished to the author free of expense. Competitors are requested to write upon foolscap paper, on one side only. A motto must be used instead of the writer's name, and each paper must be accompanied by a sealed envelope bearing the motto outside and containing the writer's name and address inside. All communications to be addressed to the honorary secretaries, A. Liversidge and A. Leibius.

A LECTURE on "Cholera, what it is, and how it may be guarded against," will be given by Prof. Burdon-Sanderson at Toynbee Hall, 28, Commercial Street, E., on Thursday, March 26, at 8.15 p.m.

A MEETING of scientific men was held on Saturday at the University College, Liverpool, at which it was resolved to prepare a scheme for investigating the marine fauna of the neighbouring seas, so that a commencement of the work might be made during the ensuing summer. Prof. Herdman had the organising and details entrusted to him.

THE Duke of Westminster and the Committee of the Sunday Society have issued invitations to a National Conference with authorities and officers of museums, art galleries, and libraries which have been open in the United Kingdom on Sundays. The Conference has been called specially for the purpose of directing the attention of Parliament to the results which have attended the Sunday opening of museums, art galleries, and libraries in the United Kingdom, and it is expected tbat representatives will be present from each of these institutions. The Conference will assemble at St. James's Hall, on Wednesday, March 25, at half past two, and the proceedings will commence at three o'clock precisely.

AT the meeting of the Society of Arts on Wednesday, the 25th inst., Mr. A. J. Ellis will read a paper on the "Musical Scales of Various Nations." The paper will be illustrated by playing the scales, and occasionally strains on properly tuned instruments, and will form a continuation of the paper on the "History of Musical Pitch," read by Mr. Ellis before the Society in 1880. It is the result mainly of an examination of native instruments and performers, by which the exact pitch of the notes used was determined by Mr. Ellis and Mr. Hipkins, and will exhibit the scales in use in ancient Greece, in Arabia, India, Java, China, Japan, and other countries. The chair will be taken by Sir Frederick Abel, the Chairman of Council of the Society.

THE Committee of the Saltpetre Producers' Association, on the west coast of South America (Comité Salitrero at Iquique, Chili) offers 1000*l*. in prizes for essays on the use of nitrate of soda as manure. Of this amount (1) a prize of 500*l*. will be awarded for the best popular essay showing the importance of nitrate of soda as a manure, and the best mode of its employment. The essay, in its theoretical part, is to treat of the effect of nitrate of soda on vegetation, as compared with other manures containing nitrogen, and should exhibit the present state of knowledge on this point. In its practical part the essay is to give directions for the use of nitrate of soda in the various conditions of plant-culture. References and quotations, and purely scientific explanations, if necessary, are to appear as notes. The essay may be written in English, German (Italic character), or French. The writing must be distinct, and on one side of the paper only. It is desired that the length of the essay may not exceed six sheets of printed octavo. Each manuscript is to be signed with a motto; the name and address of the author is to be given in a sealed envelope bearing the motto outside. The essays are to be sent on or before October 1, 1885, to any of the undermentioned judges. (2) A prize of 500*l*. will be awarded for the best essay treating of the same subjects on the basis of new experimental researches, made by the author himself. The essays must fulfill the conditions already mentioned. They may be sent to any of the judges on or before January 1, 1887. The Committee of judges consists of the following agricultural chemists:—Germany: Prof. Paul Wagner, Director of the Agricultural Station at Darmstadt. England: Mr. R. Warington, Agricultural Laboratory, Rothamsted, St. Albans, Herts. United States of America: vacant. France: Prof. L. Grandeau, Director of the Agricultural Station, and Dean of the Faculty of Natural Philosophy at Nancy. Belgium: Prof. Petermann, Director of the Royal Agricultural Station at Gembloux. Holland: Prof. Adolf Meyer, Director of the Agricultural Station of the State at Wageningen. Russia: Prof. L. Thoms, Director of the Agricultural Station at the Polytechnical Institution at Riga. If none of the essays received should thoroughly satisfy the committee of judges, they are authorised to award inferior prizes of not less than 150*l*. each. Any essay for which a prize is awarded becomes the absolute property of the Saltpetre Producers' Association at Iquique, which also reserves to itself the right of translation into other languages.

IN his series of lectures on electricity, M. Becquerel *fils* exhibited at the Conservatoire des Arts et Métiers a loud speaking telephone, which was heard without difficulty throughout the amphitheatre. This will be one of the attractions of the forthcoming electrical exhibition at the Observatoire. The halls will be lighted by a new lamp constructed by MM. Breguet and Co.

THE January number of the *Melbourne Review* contains a very interesting article on the climatic vicissitudes of Victoria, by Mr. G. S. Griffiths. Referring to the researches of Baron von Müller, the writer says that that learned botanist has discovered striking testimony to the occurrence of rapid climatic changes in Australia. First he found that during the older Pliocene period the Australian flora was lauraceous—plants of the warmth-loving laurel family predominating. In the newer Pliocene deposits these laurels have been swept away, and are replaced by a meliaceous flora and by plants of a still more tropical character. Once more an active vegetation disappears, and in its stead the myrtle family, with its characteristic eucalypts, overspreads the whole land, and still keeps possession. What great climatic vicissitudes (Mr. Griffiths asks) could rob a region of a whole suit of vegetation and repeat the act twice within a brief period? He thinks this evidence to be strongly corroborative of the occurrence of interglacial periods. There

are, however, other facts. The pepper plant (*Drimys an'artica*) is a native of the colder regions of the globe. When the Glacial epoch set in and a chilly temperature advanced to the equator itself, this plant marched forward with it in the same regions. When the interglacial warm period came on the cold temperature relaxed; but wherever the pepper plant had access to lofty mountains it retreated to their cold peaks, and so secured itself permanently in its new home. Then it died out on the hot plains, and thus Mr. Griffiths explains its existence upon the lofty ranges of New Guinea and Borneo, but nowhere else until we get far down into the colder regions of the southern hemisphere—its natural habitat. In the same manner cold-loving European plants crossed the hot tropics, unknown ages since, but probably at the same epoch, and established themselves in Australia; and so, when botanists in exploring the Australian mountains climbed to an altitude of 5000 feet, they met thirty-eight species of European plants, isolated from their fellows, and thousands of leagues from their home.

THE Russian Government has ordered from a Paris balloon factory two elongated silk balloons, in order to experiment on their direction by electricity. The Italian Government has also ordered two silk balloons equipped with telephones, &c., for captive ascents.

To the *Astronomische Nachrichten*, Nos. 2651–52, Herr von Gothard contributes an elaborate paper on the periodicity of the changes observed in the spectrum of β Lyræ during the year 1884. The observations of the previous year had already determined changes in the intensity of the bright bands, which could not be accounted for by mere atmospheric influences. Since then thirty fresh observations have enabled the author to follow through successive periods the shiftings of the bands D_3 from an almost brilliant intensity to their total disappearance. He was prevented by the unfavourable atmospheric conditions from determining the duration of the several periods, which however seemed to average not more than seven days. The hydrogen lines and also very probably those of the red, although more constant, also seem subject to periodical change. The spectroscopic phenomenon is of such a remarkable and unique character that observers are urged to direct their attention to this highly interesting star, with a view to a more accurate determination of its periodicity. Appended to the paper is a brief summary of the thirty observations taken at intervals from February 18 to November 17 of last year. Of these the following may be quoted as bearing on the short duration of the periodic changes:—July 13, D_3 of almost dazzling brightness; July 17, D_3 very faint; September 17, D_3 scarcely perceptible; September 24, D_3 again brilliant; November 1, D_3 invisible; November 5, D_3 bright.

AN important point in connection with recent seismic investigation in Japan which does not yet appear to have been noticed in this country, is the various intensities of the same shock and of different shocks at different places. One place appears more subject to earthquakes than another place which may be near at hand, and to be more violently affected than the latter by an earthquake which visits both. Thus, with similar instruments placed at the corners of a triangle having sides about 800 feet long, Prof. Milne has obtained conclusive evidence that, while at one corner there might be sufficient motion to shatter a building, at the other corners the disturbance would be trivial. In the last severe shock by which the capital of Japan was visited, the chimneys of the British Legation were shaken so severely that they had to be rebuilt, but the Russian Legation, a building of much the same character a mile away, suffered no appreciable damage. If in further investigation it turns out that certain portions of the same earthquake district are comparatively free from violent shocks, while the force of the earthquakes are concentrated in certain others, then seismic surveys would appear an indispensable pre-requisite of building in earthquake countries. A residence in "a desirable situation" would in that case mean, not one commanding a good view, or close to the station, church, and post-office, or convenient for a pack of hounds, but one built on an oasis unsympathetic to earthquakes, and which remains still and secure while its neighbours are being tossed about and destroyed by seismic forces.

THE Sixth Circular of Information of the United States Bureau of Education for 1884, compiled by Miss Annie T. Smith, a Member of the Office, is a digest of the information gained there on the subject of rural schools. It is hardly necessary to refer here to the difficulty of a thinly populated country like America—viz. the smallness of the schools, and hence, in defiance of State laws, the smallness of teachers' pay and teachers' qualifications. High authorities are here cited as to the ease with which much valuable information might be imparted to many such teachers who sorely need it. Good technical rules accordingly for teachers in any country, and a list of about eighty books bearing upon education and desirable for a schoolmaster's library are here given. The Circular records the eager desire for new ideas on the subject of elementary instruction manifest in all countries; and after quoting the highest English and American authorities on the subject, it gives a *résumé* of some recent publications of the Belgian and French Governments. The principal result of it all is to insist upon the great value of general object-lessons; for which purpose, moreover, French schools are cited as being provided with specimens of the materials used in the trades of the neighbourhood: to urge the teaching of geography first from the nearest surrounding view, and *then* from the map which has thus been made intelligible; of elementary arithmetic also by objects. The way in which, in agricultural di tricts, this object-learning goes on side by side with book-learning, especially in the cases of the youngest boys whose time is divided between school and labour, makes it a familiar phrase in America that "our brightest boys come from the country."

IN the report of the Temple Observatory at Rugby for 1884, Mr. Seabroke, the Honorary Curator, reports that the original work done during the past year consisted of the measurement of positions and distances of double stars, in continuation of that of former years. 264 complete measures of 108 stars were taken. The observations of double stars of the last four years have, it is stated, been presented to the Royal Astronomical Society, and ordered to be printed in the *Memoirs*. They number about 900 complete measures. A new list of stars for measurement in coming years has been prepared by Mr. Seabroke, with the assistance of Mr. C. H. Hodges. Some few measurements have also been made of the motion of stars in the line of sight with the spectroscope on the reflector.

THE decreasing tendency of the lobster fishery in America is becoming so marked that the United States Fisheries Commission is instituting inquiries into the causes operating against it. It is intended to investigate all points connected with the natural history of the species, the condition of the fishery grounds, &c., in order to arrive at a satisfactory conclusion on the subject.

THE Council of the National Fish Culture Association have decided to form an ichthyological library containing works of every description on the subject of our fish and fisheries, their culture and development.

WE have received separate reprints of the following papers read before the Chemical Society:—"On Additive and Con-

densation Compounds of Diketones with Ketones," by Messrs. Japp and Miller, and "On Condensation of Benzil with Ethyl Alcohol," by Dr. Japp and Miss Mary E. Owens.

WE have received from Messrs. Lancaster and Son, of Birmingham, a catalogue of photographic apparatus for dry-plate photography, and a useful illustrated pamphlet, "How to be a Successful Amateur Photographer," by W. J. Lancaster, F.C.S.

THE additions to the Zoological Society's Gardens during the past week include a Bonnet Monkey (*Macacus sinicus* ♀) from India, presented by Mrs. Thomas; a Grey Ichneumon (*Herpestes griseus*) from India, a Vulpine Phalanger (*Phalangista vulpina* ♂) from Australia, presented by Mr. J. G. Baxter; a Plantain Squirrel (*Sciurus plantani*) from India, presented by Lieut. A. H. Oliver, R.N.; a Barn Owl (*Strix flammea*), British, presented by Mr. W. P. Clark; a Red-billed Whistling Duck (*Dendrocygna autumnalis*) from South America, presented by Mr. Wm. Boutcher; an Indian Crocodile (*Crocodilus palustris*) from India, presented by Mr. John Murphy; a Common Boa (*Boa constrictor*) from South America, presented by Mr. Allen; an Algerian Tortoise (*Testudo mauritanica*) from North Africa, deposited; a Red-eared Monkey (*Cercopithecus erythrotis* ♂), a Pluto Monkey (*Cercopithecus pluto* ♀), a White-thighed Colobus (*Colobus vellerosus* ♂) from West Africa, a Hairy-nosed Wombat (*Phascolomys latifrons* ♀), a Blood-stained Cockatoo (*Cacatua sanguinea*) from South Australia, purchased; three Long-fronted Gerbilles (*Gerbillus longifrons*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

TEMPEL'S COMET (1867 II.).—M. Raoul Gautier has circulated an ephemeris of this comet, intending to communicate the details of his calculation of the effect of the perturbations of Jupiter during the comet's long continuance in the neighbourhood of the planet in the last revolution to the *Astronomische Nachrichten*. The ensuing perihelion passage is retarded thereby rather more than 148 days: the major-axis of the orbit is considerably increased and the eccentricity diminished. As a consequence the perihelion distance receives a very important augmentation. This result, which could not have been foreseen without at least an approximate determination of the perturbations occasioned by the attraction of Jupiter, materially diminishes the chances of observing the comet during the present year, and indeed in future years, so long as the elements do not undergo considerable change. M. Gautier finds that the perihelion passage is delayed until September 25, but that the nearest approach of the comet to the earth occurs on March 31, when its distance is 1·51. The maximum theoretical intensity of light which is attained on April 10 is only 0·074 (if expressed in the usual manner); for comparison with this value, it may be remarked that on August 21, when Schmidt last observed the comet for position in that year, perceiving it, as he says, only "blickweise," the intensity of light was 0·21, and at M. Tempel's last observation at Florence on July 8, 1879, it was 0·33. It will therefore be obvious that the observation of the comet in the present year is at least doubtful, but an extract from M. Gautier's ephemeris, applying to the next period of absence of moonlight, is subjoined:—

At Berlin Midnight

	R.A. h. m. s.	Decl. ° ′	Log. distance from Earth	Sun
April 2	11 55 17	+18 56·3	0·1792	0·3877
4	11 53 44	18 58·2		
6	11 52 14	18 59·1	0·1803	0·3851
8	11 50 47	18 58·9		
10	11 49 24	18 57·7	0·1824	0·3826
12	11 48 5	18 55·3		
14	11 46 52	18 51·8	0·1855	0·3801
16	11 45 43	18 47·2		
18	11 44 40	+18 41·6	0·1894	0·3776

The elements of the orbit are as follows (M. Eq. 1885·0):—

Perihelion passage, 1885, September 25·7649 M.T. at Berlin.

Longitude of perihelion	241° 26′ 1″·0
,, ascending node	72 28 7·7
Inclination	10 50 27·2
Angle of excentricity	23 53 57·0
Log. semi-axis major	0·542244
Mean daily sidereal motion	545″·3073

The perihelion distance in 1867, in which year the comet was first detected by M. Tempel, was 1·564, the earth's mean distance from the sun being taken as unity: the above elements show that at perihelion passage in 1885, this distance will have been increased by perturbation to 2·073. The nearest approach of the comet to the earth's orbit occurs at or very close to perihelion, and it will appear that under the most favourable conditions, with the orbit of 1885, the theoretical intensity of light cannot exceed one-sixth of the value which it might have attained in the orbit of 1867. At aphelion in the new orbit the comet approaches that of Jupiter within 0·17.

THE VARIABLE STAR MIRA CETI.—Mr. Knott, who has had this star under close observation at Cuckfield since January 7, has ascertained that a maximum of 2·9 m. occurred on February 11, which is fourteen days later than given by the formula of sines in Prof. Schönfeld's second catalogue. The next minimum may be expected to fall about the middle of September, and the following maximum in the first days of January, 1886, assuming that there is a similar retardation on the date assigned by the formula.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, MARCH 22–28

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 22

Sun rises, 6h. 0m.; souths, 12h. 6m. 53·8s.; sets, 18h. 15m.; decl. on meridian, 0° 49′ N.: Sidereal Time at Sunset, 6h. 16m.

Moon (at First Quarter on March 23) rises, 9h. 22m.; souths, 17h. 12m.; sets, 1h. 5m.*; decl. on meridian, 17° 55′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 15	12 40	19 4	4 5 N.
Venus	5 50	11 28	17 6	4 57 S.
Mars	5 51	11 38	17 25	3 23 S.
Jupiter	14 42	21 57	5 12*	13 38 N.
Saturn	9 3	17 8	1 13*	21 47 N.

* Indicates that the setting is that of the following day.

Occultations of Stars by the Moon

March	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image °	°
22	111 Tauri	5½	18 52	19 54	84	334
22	117 Tauri	6	21 2	21 23	56	19
24	68 Geminorum	5½	23 39	0 37†	122	294
26	B.A.C. 2872	6	0 41	1 38	113	295
27	*h* Leonis	6	1 45	2 36	82	319
27	B.A.C. 3529	6	22 24	23 23	37	303
27	43 Leonis	6	23 37	0 28†	131	233
28	B.A.C. 3836	6	22 19	23 19	24	290

† Occurs on the following day.

Phenomena of Jupiter's Satellites

March	h. m.		March	h. m.	
22	3 39	II. occ. disap.	25	4 11	IV. ecl. disap.
	20 17	I. tr. egr.		21 16	II. ecl. reap.
23	21 46	II. tr. ing.	27	3 58	I. occ. disap.
24	0 41	II. tr. egr.	28	1 18	I. tr. ing.
	18 43	III. ecl. reap.		1 50	III. tr. ing.
	20 49	IV. occ. disap.		3 37	I. tr. egr.
25	1 29	IV. occ. reap.		22 25	I. occ. disap.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

March	h.	
22	16	Saturn in conjunction with and 3° 56′ north of the Moon.

March	h.	
27 ...	15 ...	Jupiter in conjunction with and 4° 40′ north of the Moon.
28 ...	3 ...	Venus in conjunction with and 0° 36′ south of Mars.
28 ...	9 ...	Mercury at least distance from the Sun.

GEOGRAPHICAL NOTES

DR. R. VON LENDENFELD, in a letter to Prof. Cayley dated Sydney, January 24, 1885, writes as follows:—I have been sent by the Geological Survey Department of this colony to make a scientific investigation of the central part of the Australian Alps and have returned a few days ago. I found out that the peak, considered as the highest hitherto, which has been measured by several scientists and named Mount Kosciusko, is *not the highest*, and made the first ascent of the highest peak some distance further south. I calculated the height of the latter at 7256 feet (Mount Kosciusko has been measured at 7176, 7175, and, by myself, at 7171 feet). I name this hill after our celebrated geologist, the Rev. W. B. Clarke, Mount Clarke. Further, I discovered indubitable signs of prehistoric glaciers above 5800 feet, and photographed some beautiful *roches moutonnées*. A large valley was filled at the glacial period by a glacier extending 500 feet up its sides. I had excellent weather, and photographed the panorama from the summit of Mount Kosciusko. I had one guide and a geological assistant with me. We camped only three nights, and had glorious weather all the time. The upper limit of trees lies at a height of 5900 feet. Patches of snow are found attached to the leeside of the main range above 6500 feet all the year round—in the European Alps such little *névés* would not lie below 8000 feet—another proof for the lower temperature and greater amount of wet south of the equator, as our Alps lie 46°–48° N., and Mount Kosciusko 37° S. I collected many flowers and geological specimens, and found the whole trip equally enjoyable and interesting. It froze every night, and I cannot tell you how happy and comfortable I felt in the brisk cold air up there, after having been confined to the hothouse climate of Sydney for a year.

THE Vienna correspondent of the *Times* telegraphs that at a private meeting of the committee of the Imperial Geographical Society of Vienna, it has been resolved that Dr. Oscar Lenz, Secretary of the Society, should be sent on a new expedition to explore the watershed between the Nile and the Congo. This expedition has been planned chiefly by Baron Leopold Hofmann, late Imperial Finance Minister, and now President of the Austrian African Association. Dr. Lenz will visit the stations of the International Belgian Society, and one of the objects of his journey will be to find traces of Dr. Junker, Dr. Schnitzler (known in Egypt as Emin Bey), Signor Cassati, and Lupton Bey. Dr. Lenz's journey will be under the special patronage of the Crown Prince of Austria and the King of the Belgians, and the cost will be defrayed partly by the Geographical Society of Vienna, partly by the Government and from private subscriptions. Dr. Lenz proposes to start early in May.

AT the meeting of the Geographical Society of Paris, held on the 6th inst., M. Mascart in the chair, Prince Roland Bonaparte referred to the recent exploration of the Van Braam Morics in New Guinea.—A correspondent of the Society wrote from Ciudad Bolivarin Venezuela that it was reported there that one of the members of the Crévaux mission was still living in captivity among a tribe of Indians, and it is also stated that fragments of a paper were found in a Bolivian forest, on which were written in letters of blood the name of the prisoner and his fate.—M. Teisserenc de Bort described the oasis of Djerid in Tunis. It contains 9,700 inhabitants.—A communication was read with reference to the tribes employed in the recent revolt in Morocco, correcting the names given to them.—M. Schrader read a paper on the masses of snow moved about by the wind amongst mountains. These masses are not carried about by chance—they obey very simple laws, which cause them to be deposited at spots where the wind is diminished in intensity, and give them forms which may easily be analysed when we take into account the quality of the snow, the force and direction of the wind, and the contour of the mountains.—M. Rabot described the results of the mission with which he was charged by the Minister of Public Instruction to explore Northern Finland and Russian Lapland. He explored especially the valleys of the Pasvig and Talom, as well as Lake Enara. The whole region is one immense forest, with lakes and peat-bogs scattered everywhere, and cut up by numerous water-courses. These rivers are the only means of communication, but their navigation is most difficult, on account of cascades and rapids. Lake Enara, which is drained by the Pasvig, is described by M. Rabot as a veritable inland sea, with hundreds of islets covered with magnificent pine trees. The climate is very rigorous. Winter begins in September, and the ice is still in the ground in the beginning of June. The spring is short, but comparatively warm, and it is not rare to see the frost again in August. The country around Lake Enara is level and little broken, and forms a depression between the plateau of Finmark and the masses of hills which stud Russian Lapland.

A WORK which will shortly be published by Prince Roland Bonaparte deals with the populations of Dutch Guiana from an anthropological and sociological point of view. He has studied three groups of the population: (1) the Indians (Caribs); (2) wild Negroes, or Negroes of the woods, being fugitive slaves who have returned to savage life; (3) freed slaves or settled Negroes. The section on the Negroes who have returned to their original state is probably the most interesting of the three. Many of these are descendants of slaves who fled from ill-treatment in the early days of the colony to the woods and inaccessible solitudes of the highlands. In 1712, when Admiral Cassard laid siege to Paramaribo, the planters sent away their slaves into the interior, so that they should not fall into the invader's hands, and they refused to return after the peace. Gradually their number augmented, and these Negroes formed themselves into villages and cultivated land. They grew so powerful that after several bloody and expensive wars, the Colonial Government found it expedient to make a treaty of peace, recognising them as allies, in 1762. At the present moment they number 8000 souls, and are divided into four sections or tribes, according to the locality in which they have settled. They appear to have preserved most of the characteristics of the Negro, but they have adopted many of the habits and modes of life of the Indians, by whom they are surrounded.

THE first number of the *Scottish Geographical Magazine*, the organ of the new Scottish Geographical Society, has been issued. It aims at being much more than the organ of the Society, however. It begins with Mr. Stanley's opening address, and a somewhat perfervid article on Scotland and geographical work. This is followed by a most instructive article by Prof. James Geikie on the physical features of Scotland, accompanied by a map essentially new in design and nomenclature. The geographical notes occupy about fourteen pages, and are unusually full and comprehensive, aiming at a nearly exhaustive chronicle of geographical progress in all departments. This is followed by a *résumé* of geographical literature for 1884, new books and new maps. Besides Prof. Geikie's map there is one of the river basins of Africa, and a portrait of Mr. Stanley. Altogether the *Magazine* is a valuable addition to the literature of its class, creditable to the enterprise of the Society and the knowledge and intelligence of its editors.

ACCIDENTAL EXPLOSIONS PRODUCED BY NON-EXPLOSIVE LIQUIDS[1]

TEN years ago the lecturer discussed in some detail the various causes of the continually recurring casualties which are classed under the head of accidental explosions, and he then had occasion to compare the causes of coal-gas explosions, the occurrence of which is as deplorably frequent now as it was then, with those of accidents connected with the transport, storage, and use of volatile inflammable liquids which are receiving extensive application, chiefly as solvents and as illuminating agents.

Within the last few years he has had occasion to devote special attention to the investigation of instances of this class of accident, and to examine more particularly into the probable causes of frequent casualties connected with the employment of lamps in which the various products included under the general designations of petroleum and paraffin oil are burned. The latter branch of these inquiries, which is still in progress, has been conducted in association with Mr. Boverton Redwood, the talented Secretary and Chemist of the Petroleum Association, and with the valuable aid of Dr. W. Kellner, Assistant-Chemist

[1] Address delivered at the Royal Institution of Great Britain, Friday, March 13, 1885, by Sir Frederick Abel, C.B., D.C.L., F.R.S., M.R.I.

of the War Department. Although it may be hoped that their continuation will lead to further data and conclusions of practical and public importance, it is thought that some account of facts already elicited may interest the members of the Royal Institution, and possess some general value.

Ever since liquids which, more or less rapidly, involve inflammable vapour when freely exposed to air, or partially confined, have been in extensive use, casualties have occurred from time to time through the accidental or thoughtless ignition of the mixtures of vapour and air thus formed, whereby more or less violent and destructive explosions have been produced, often followed by the ignition of the exposed liquid which is the source of the explosive mixture, and by the consequent frequent development of disastrous conflagrations.

Many instances are on record of explosions, sufficiently violent to produce effects destructive or injurious to life and property, resulting from the application of flame to vessels which had contained either the more volatile coal-tar- or petroleum-products, or strong spirituous liquids, and which, though they had been entirely or nearly emptied of their contents, still contained, or retained by absorption within their body, some of the volatile liquid, this having, by evaporation into the air in the emptied receptacle, produced with it a more or less violently explosive mixture. Thus, a loud explosion occurred at the entrance of a lamp-maker's shop in Whitecross Street, which was found to have been caused by a boy throwing a piece of lighted paper into a cask standing under the gateway, which had contained benzoline; two boys were very seriously injured by the blast of flame which was projected from the barrel. A perfectly analogous accident was soon afterwards reported in the papers as having occurred at Sheffield, with serious injury to the author of the catastrophe and another boy; and a very similar case occurred at Exeter during the removal of some empty benzoline barrels, consequent upon a boy applying a lighted match to the hole of one of them. Again, at Spaxton in Somersetshire, a young man applied a light to the hole of a benzoline cask, described as nearly empty, which was standing in the road, when three young men were blown across the road, one of them being so seriously injured about the head that he died.

Explosions with similarly disastrous results have also been publicly recorded as having resulted from the application of a light to rum puncheons and whisky casks, even some time after they have been emptied of their contents, the evaporation of the alcohol absorbed by the wood having sufficed to convert the confined air into a violent explosive mixture.

The readiness or extent to which inflammable vapour is evolved from those products of the distillation of petroleum, or of shale or coal, which are used for illuminating purposes, differs of course considerably with the character of these liquids. Those which are classed as petroleum spirit (known as gasoline, benzine, benzoline, naphtha, japanners' spirit, &c.), and in regard to which there exist very special precautionary enactments, are, it need scarcely be said, of far more dangerous character than those classed as burning oils, which include the paraffin oils obtained from shale and the so-called flashing points of which range from 73° to above 140° Fahrenheit. The rapidity with which the vapours, evolved by the more volatile products on exposure to air, or by their leakage from casks or barrels, diffuse themselves through the air, producing with it more or less violent explosive mixtures, has been a fruitful source of disaster, sometimes of great magnitude. The lecturer had occasion to refer, in his discourse of 1875, to an accident at the Royal College of Chemistry of which he was a witness, in 1847, when the lamented Mr. C. B. Mansfield was engaged in the conversion of a quantity of benzol into nitrobenzol in a capacious glass vessel, which suddenly cracked, allowing the warm liquid hydrocarbon to escape and flow over a large surface. This occurred in an apartment 38 feet long, about 30 feet wide, and 10 feet high; there was a gas jet burning at the extremity of the room opposite to that where the heated liquid was spilled, and within a very brief space of time after the vessel broke, a sheet of flame flashed from the gas jet along the upper part of the room, to the spot where the fluid lay scattered.

The origin of a fire which occurred at some mineral oil stores at Exeter in 1882 affords another striking illustration of the great rapidity with which the vapour of petroleum spirit will diffuse itself through the air. The store which caught fire, and which contained both petroleum oil and spirit, or benzoline, was one of a range of arched caves upon the bank of a canal, being separated from it by a roadway about 50 feet wide. It was a standing rule at the stores that no light should be taken to any one containing benzoline. The casks which contained this liquid were to be removed, and the foreman, desirous of beginning this work early, and forgetful of the rule, went to the store shortly before daylight, carrying a lighted lantern, which he placed upon the ground at a distance of several feet from the door. He then proceeded to open these. As he did so, he noticed a very powerful odour of benzoline, and, almost immediately, he saw a flash of flame proceed from the lantern to the store. He had just turned to escape, when an explosion occurred which blew the doors and the lantern across the canal; the benzoline in the store was at once inflamed, and flowed out into the road and upon the surface of the water, firing a small vessel which lay against the quay, and setting fire to the stores of benzoline contained in two neighbouring caves.

Many exemplifications might be cited of the danger arising from the accidental spilling or escape of petroleum spirit (or even of oils of very low flashing point) in the ordinary course of dealing with these liquids, as in stores where there is but very imperfect ventilation, and in some part of which a flame exists, or is carelessly introduced; or from the escape of spirit or its vapour from stores or receptacles to adjacent spaces where, its existence being unsuspected, the ignition of the resulting explosive mixture of vapour and air may be at any time brought about.

Without referring to accidents which have been due to flagrant carelessness in introducing a flame or striking a light in a store where petroleum vapour is likely to exist in the air, or where some form of spirit has been accidentally spilled, a few instances may be quoted which illustrate the magnitude of casualties liable to arise from the causes just referred to. Some years ago an explosion productive of much damage occurred in a sewer at Greenwich, and was clearly traced to the entrance into the sewer of some petroleum products (from a neighbouring patent gas factory); the vapours from these had diffused themselves through the air in the sewer to a considerable distance, forming with it an explosive mixture which must have been accidentally ignited at one of the sewer openings in the street above. Last spring a similar accident occurred at Newport in Monmouthshire, a quantity of benzoline having escaped into a sewer from a neighbouring store; the ignition of the resulting explosive mixture of vapour and air, with which a considerable length of the sewer became filled, tore up the roadway to some distance, several persons being thrown down. A terrific disaster of the same class was reported from San Francisco in November, 1879. During the driving of a tunnel in the San Jose Santa Cruz Railway, a vein of petroleum became exposed by the excavators, who were, of course, working with naked lights. Three violent explosions occurred in consequence, in rapid succession, resulting in the death of twenty-five Chinamen and in the injury of seventeen others and two white men.

Another accident, which occurred near Coventry nearly five years ago, may be quoted in illustration of the unsuspected manner in which explosive gas-mixtures may exist in localities which, to the superficial observer, may appear to have no connection with a neighbouring locality where volatile liquids are liable to escape confinement.

A dealer in benzoline spirit kept his small store of that liquid (from 20 to 80 gallons) in an apartment of his house, upon the basement, the floor of the room being paved with red bricks. At a distance of about three feet from the store-room there was a well, the depth of which to the surface of the water was twenty feet. The well was closed in almost entirely with planks covered with earth. The water in the well being found foul, the owner had the latter uncovered, with a view to its being cleared out. The workman in charge of the operation, after having been engaged for three hours in pumping out a large quantity of the water, lowered a lighted candle into the well, according to the usual practice, to see whether he could descend with safety, when, while bending over the opening, he perceived a blue flame shooting upwards, and was violently thrown back and badly burnt, a woman who was watching him being similarly injured. The benzoline which had been spilled from time to time in small quantities in filling the cans of customers had readily passed through the porous brick upon which it fell, and, gradually permeating the soil beneath, had, in course of time, drained into the adjacent well. That this must occur under the circumstances described would have been self-evident to any one acquainted with the behaviour of these liquids and with th

attendant circumstances. In localities where large quantities have for some time been stored in the usual casks or barrels, there is no difficulty in "striking oil" by sinking a well in the immediately adjacent ground, in consequence of the large amount of leakage of the spirit or oil which must unavoidably occur. Even in the absence of leakage from the openings of the barrels, or from any accidental imperfection, considerable diffusion of the volatile liquid, and consequent escape by evaporation through the wood itself, must occur in large petroleum-stores, especially if much exposed to the sun, and in the holds of ships where the temperature is generally more or less high. Even the precaution adopted of rinsing the barrels before use with a stiff solution of glue is not effectual in preventing the escape of the spirit from these causes, as the effect of alternations of temperature upon the barrels must tend to reopen any unsound places temporarily closed by the glue. Even at very extensive depôts, where special arrangements were adopted to maintain the stores uniformly at a very moderate average temperature, the loss of petroleum spirit from leakage and evaporation was estimated, ten years ago, to amount to about 18 per cent. of the total stored, while the average loss from the same causes upon petroleum oil was about 9 per cent. By the introduction, from time to time, of improvements of the arrangements, the loss of spirit by leakage and evaporation has been very considerably reduced, amounting to less than 8 per cent. in well-constructed stores, while at some petroleum stores, more especially in Germany, the loss of oil from leakage is now said not to exceed 1 per cent.

As in the case of the loss of coal-laden ships by explosions on the high seas, such loss has probably, in many cases, been due to the development of gas from the cargo, and to its diffusion into the air of parts of the ship more or less distant from the coal, producing an explosive atmosphere which might become ignited by the conveyance or existence of a light or fire, where its presence was not deemed dangerous; so also it is not improbable that the supposed loss by effects of weather of missing petroleum-laden vessels may have occasionally arisen from fire, caused in the first instance by the diffusion of vapour escaping from the cargo through the air in contiguous parts of the ship, and the accidental ignition of the explosive atmosphere thus produced.

The possibility of such disasters has been demonstrated by the repeated occurrence of accidents of this class in ports or their vicinity. A very alarming instance of the kind occurred in 1871 on the Thames off Erith. Two brigantines had nearly completed the discharge of their cargoes of petroleum spirit ("naphtha"), when another vessel, the *Ruth*, from Nova Scotia, containing upwards of 2000 barrels of the same material, together with other inflammable cargo, anchored alongside them. This ship had encountered very severe weather, and it had been necessary to batten down the hatches; the cargo in the hold had consequently become enveloped in the vapour which had escaped from the casks. On the removal of the hatches, an explosive mixture was speedily produced by access of air, and, through some unexplained cause, became ignited shortly after the vessel anchored. A violent explosion followed, and the vessel was almost instantly in flames, the fire being rapidly communicated to the other two ships, which were with difficulty saved, after sustaining considerable injury, while the *Ruth*, in which the fire raged uncontrollably, was after a time towed to a spot where she could burn herself out and sink without damage to the other shipping. Three of the crew were seriously injured by the explosion, and the mate was blown to some distance into the water.

In June, 1873, a vessel (the *Maria Lee*), laden with 300 barrels of petroleum and other inflammable cargo, was destroyed by fire on the Thames near the Purfleet powder magazines, consequent upon the explosion in her of a mixture of petroleum-vapour and air; and a similar accident occurred about the same time in Glasgow harbour. In the case of the *Maria Lee* it was clearly proved that the vapour resulting from leakage and evaporation of the spirit in the hold had diffused itself through the ship during the night, which was very hot, the hatches having been kept closed and covered with tarpaulin, in consequence of the occurrence of a thunderstorm. Upon the captain entering his cabin in the after part of the ship early in the morning (and probably striking a light) a loud explosion took place, and flame was immediately seen issuing from the fore-part of the ship.

A very similar casualty to the foregoing occurred at Liverpool four years afterwards, in a small vessel laden with petroleum-spirit, which proved not to have been at all adapted by internal construction for the safe carriage of such a freight. The cargo of 214 barrels of spirit had been stowed on board, and the hatches were put down and covered with tarpaulin. The cabin and forecastle of the smack were below deck, and were only separated by a thin partition from the hold. The loading had been completed between six and seven o'clock in the evening, and at about eight o'clock the captain went into the cabin and kindled a lamp. A man upon deck, who with another was injured by the explosion and fire, saw the light burning in the forecastle, and almost immediately afterwards the deck was lifted and the man was thrown some distance, while flame issued from the hold. The captain was terribly burned, and died shortly afterwards. In vessels which are constructed for the American petroleum trade, the cabins and forecastles are all upon deck, that part of the vessel which carries the freight, between decks, being as completely as possible separated from the other parts of the ship.

In some instances, ships laden with petroleum oil have become inflamed, in an unexplained manner, without the occurrence of any noticeable explosion, as was the case last year with a large vessel (the *Aurora*) in the port of Calcutta, after she had discharged more than half her cargo of 59,000 cases. The vessel burned for nine hours, the river becoming covered with burning oil as she gradually filled with water; the direction of the wind and the condition of the tide at the time of her sinking fortunately prevented the fire from reaching the shipping higher up the river.

There is no doubt that, while with cargoes of the more volatile petroleum products, classed as spirit, the greatest precautions are necessary to guard against the possible ignition of more or less explosive mixtures of vapour and air which will be formed in the stowage spaces of ships, and which may extend to other parts of the vessels unless very efficient ventilation be maintained, ships laden with the oils produced for use in ordinary petroleum or paraffin lamps, and which, yielding vapours at temperatures above the standard fixed as a guarantee of safety, incur comparatively very little risk of accident, provided simple precautions be observed. If, moreover, by some act of carelessness, or some accident not guarded against by the prescribed precautions, a part of such cargo does become ignited, the prompt and, as far as practicable, complete exclusion of air from the seat of fire, by the secure battening down of the hatches, will most probably save the ship from destruction. There are numerous records of vessels having discharged cargoes of petroleum oil, many barrels of which have been found greatly charred on the outside, occasionally even to such an extent that the receptacle has scarcely sufficient strength remaining to retain its contents. A remarkable illustration of the controllable nature of a fire in a petroleum-laden ship was furnished by the ship *Joseph Fish*, laden with refined petroleum, lubricating oil, and turpentine, which, a fortnight after leaving New York (in September, 1879), was struck by lightning during a heavy squall, the hatches being closed at the time. Smoke at once issued from below, and the force-pumps were set to work directly to keep the fire down. The hatches were removed for examination as the fire appeared to gain ground, but were immediately replaced, and, after further pumping, as the fire appeared to increase, and an explosion was feared, the crew took to their boats, remaining near the ship. Eight hours afterwards they were picked up by a passing ship, which remained near the *Joseph Fish* until daylight. Her captain then returned on board, and as he found that the fire appeared to be out, the crew returned and the ship resumed her voyage, reaching the port of London without further incident, except that, during the use of the pumps for removing the water, considerable quantities of petroleum and turpentine were pumped up with it from the hold. When the cargo was discharged, a large number of the barrels bore evidence of the great heat to which they had been exposed; several casks had gone to pieces, and the staves of others were charred quite half-way through, although they still retained their contents.

The lecturer had occasion, ten years ago, to dwell upon the recklessness with which fearful risks were incurred, in some cases no doubt ignorantly, but in others scarcely without a knowledge, on the part of those who were responsible, of the nature of the materials dealt with, by transporting volatile and highly inflammable liquids together with explosive substances in barges or other craft, and in doing so, moreover, without the adoption of even the most obvious precautions for guarding against access

of fire to the contents of those vessels. The instance of the explosion, in 1864, of the *Lottie Sleigh* at Liverpool, laden with 11½ tons of gunpowder, in consequence of the accidental spilling and ignition of some paraffin oil in the cabin of the ship, illustrated the danger incurred in permitting these materials to be together on board a vessel, and should have furnished some warning by the publicity it received; but the explosion, ten years later, on the Regent's Park canal, of the barge *Tilbury*, revealed the continued prevalence of the same reckless disregard of all dictates of common prudence in dealing with the joint transport of explosives and volatile inflammable liquids.

The efficient laws and Government inspection to which all traffic in explosives has since then been subject, have rendered the recurrence of that identical kind of catastrophe almost out of the question, but an illustration has not been wanting quite recently of the fact that, but for the respect commanded by the rigour of the law, barges passing through towns would probably still carry freights composed of petroleum spirit and powder or other explosives, being at the same time provided with a stove, lamp, and matches for the convenient production of explosions. In August, 1883, an explosion occurred on the canal at Bath, in a barge which sank immediately, the master being slightly injured; the freight of the vessel consisted of petroleum, benzoline, and lucifer-matches.

The last four years have furnished several very remarkable illustrations of great injuries inflicted on ships by explosions, the origin of which was traced to the existence on board of only small quantities of some preparation containing petroleum spirit, or benzoline, with the nature of which the men who had charge of them were not properly acquainted. These materials had, consequently, been so dealt with as to become the means of filling more or less confined spaces in the ships with an explosive atmosphere which, when some portion of it reached a flame, was fired throughout, with violently destructive effects.

The first authenticated case of an accident due to this cause occurred in June, 1880, on board the Pacific Steam Navigation Company's steamer *Coquimbo*, shortly after her arrival in the morning at Valparaiso from Coquimbo. A violent explosion took place, without any warning or apparent cause, in the forepeak of the vessel, blowing out several plates of the bow and doing other structural damage, besides killing the ship's carpenter; the explosion could only be accounted for by the circumstance that a small quantity of a benzoline preparation used for painting purposes (probably as "driers") was stored in the fore-peak and that a mixture of the vapour from this with the air had become ignited. The sufferer was the only person who could have thrown light upon the precise cause of the accident, but there was no other material whatever in that part of the ship to which the explosion could have been in any way ascribed.

In May, 1881, an explosion of a trifling character occurred on board H.M.S. *Cockatrice* in Sheerness Dockyard, in consequence of a man going into the store-room with a naked light and holding it close to a small can which was uncorked at the time, and which contained a preparation recently introduced into the naval service as a "driers" for use with paint, under the name of *Xerotine Siccative*. This preparation, which was of foreign origin, appears to have been adopted for use in the naval service and to have been issued to H.M.'s ships generally without any knowledge of its composition and without attention being directed to the fact that it consisted very largely of the most volatile petroleum spirit, which would evaporate freely if the liquid were exposed to air at ordinary temperatures, and the escape of which from a can, jar, or cask, placed in some confined and non-ventilated space, must speedily diffuse itself through the air, and render the latter more or less violently explosive.

When attention was directed to the highly inflammable character of this xerotine siccative by the slight accident referred to, official instructions were issued by the Admiralty, in June, 1881, to ships and dockyards that the preparation should be stored and treated with the same precautions as turpentine and other highly inflammable liquids or preparations.

The following November, however, telegraphic news was received of a very serious explosion on board H.M.S. *Triumph*, then stationed at Coquimbo, due to the xerotine siccative. The explosion took place early in the evening of November 23, and originated in one of the paint-rooms of the ship; the painter, and a marine who was assisting him, were in the upper paint-room at the time; the former received severe internal injuries and afterwards died, the latter was killed at once. One man standing at the open door of the sick bay furthest from the explosion was instantaneously killed, others in close proximity receiving only superficial injuries. Altogether there were two killed, two dangerously wounded—of whom one died—and six injured by the explosion.

The results of the official inquiry held at Callao led to the conclusion that the explosion was caused by the ignition of an explosive gas-mixture produced by xerotine siccative which had leaked from a tin kept in a compartment under the paint-room and quite at the bottom of the ship, usually termed the "glory hole;" that locality having been considered by the captain of the ship as the safest place in which to keep this material, to the dangerous nature of which his attention had been recently called by the receipt of the Admiralty Circular. It transpired that the painter had sent his assistant down to this compartment from the paint-room to fetch some paint. The man, who had a hand-lantern with him, while opening the hatch, which had not been opened for three days, made a remark that there was a horrible smell; the chief painter told him to return, as he thought the smell was due to foul air, and immediately afterwards the explosion occurred.

The tin can which had contained six gallons of the liquid was found, after the accident, to have received injury as though some heavy body had fallen, or been placed, upon it; this appeared to have been done before the explosion, and there is no doubt that the liquid had leaked out of the can, and had evaporated into the air in the compartment beneath the paint-room, and probably also to some extent in the adjoining spaces. The damage done was very considerable. An iron ladder leading from one paint-room to the other was so twisted up as to have lost all semblance of originality, the wooden bulkhead separating the upper paint-room and sick bay was completely blown away, the framing of the ship's side in the sick bay was blown inwards and broken, the furniture in the latter was completely shattered, and the bedding and clothes of the men near the explosion were much burned. The inquiries which followed upon this deplorable accident showed that, while due precautions were taken to store the supplies of mineral oil used for burning purposes, of turpentine and of spirit, which were sent to different naval stations for supply to the fleet, in special parts of the ship or on deck, this highly inflammable liquid, which was far more dangerous than other stores of this class, had been sent in freight-ships as common cargo, being stored in the hold without any precautions. A stone jar which was advised as containing a supply had arrived at its destination in the Pacific quite empty, the contents having leaked out and evaporated on the passage out, so that the vessel carrying it had been unsuspectedly exposed to very great danger.

(*To be continued.*)

PROGRAMME OF WORK TO BE PURSUED AT THE U.S. NAVAL OBSERVATORY AT WASHINGTON, D.C., DURING THE YEAR BEGINNING JANUARY 1, 1885[1]

The Great Equatorial

1. OBSERVATIONS of a selected list of double stars will be continued. These stars are such as have rapid orbital motions, or which present some other interesting peculiarity.

2. Conjunctions of the inner satellites of Saturn during the opposition of the planet will be observed. There will also be made a complete micrometrical measurement of the dimensions of the ring.

3. There will be made three drawings of Saturn—one before opposition; one at or near opposition; and one after opposition.

4. The observations which have been begun for stellar parallax, and for the temperature coefficient of the screw of the micrometer, will be finished.

The Transit Circle

1. Observations of the sun will be made whenever the necessary ephemeris stars can be observed, and the required instrumental corrections determined.

2. The moon will be observed through the whole lunation.

3. The major planets will be observed from fifteen to twenty times, near opposition.

[1] Transmitted by Commodore S. R. Franklin, U.S.N. Superintendent.

4. Each minor planet will be observed at least five times, near opposition, when practicable.

5. Observations of the list of miscellaneous stars will be finished as soon as practicable.

The Transit Instrument

1. Observations will be made as often as practicable for time, for the correction of the standard meantime clock; and computations will be made daily for such correction.

2. Observations for the right ascensions of the sun, moon, and inner planets to be made as frequently as possible; observations of the major planets, and of the brighter of the minor planets, to be made near opposition.

3. The observations made during 1883 will be prepared for publication; and the computations of those of 1884 continued.

The 9·6-inch Equatorial

Observations will be made :—

1. Of all the minor planets whose brightness at opposition is greater than their mean brightness.

2. Of comets, to determine position and physical peculiarities.

3. Of occultations of stars by the moon.

4. When arrangements shall have been made to photograph the sun, any sun-spots which show any decided peculiarities in the photographs will be examined with the spectroscope.

The Prime Vertical Transit Instrument

Observations of a selected list of stars in conjunction with the Royal Observatory at Lisbon, in pursuance of the plan recommended by the International Geodetic Association, for the determination of variability of latitude.

Time-Service and Chronometers

The time-balls at Washington and New York will be dropped daily at noon of the 75th meridian; and the noon signals will be extended to such other places throughout the country as may be desirable, as rapidly as arrangements may be made.

The rating of chronometers will be continued as heretofore.

Meteorological observations will be made as usual.

The Mural Circle

Observations will be made of stars down to the 7th magnitude south of ten degrees North declination, the positions of which have not been recently determined at some northern observatory; the observing list to be formed of all stars from Gould's Uranometria Argentina visible here, and not found in Yarnall's Catalogue, the Transit Circle list of B.A.C. stars, or the recent Catalogue of the Glasgow Observatory.

SCIENTIFIC SERIALS

Rendiconti del Reale Istituto Lombardo, January 29.—On a special class of involutions of space known as monoidal, by Dr. V. Martinetti.—Analysis of the meteorological observations made at the Brera Observatory, Milan, during the year 1884, by E. Pini.—An experimental study of the thermic phenomena accompanying the formation of alloys, by Prof. Domenico Mazzotto.—On some eruptive rocks occurring between Lakes Maggiore and Orta, by Prof. Giuseppe Mercalli.—On the geometrical movement of invariable systems, by Prof. C. Formenti.—International right in connection with the proposed Italian penal code, by Prof. A. Buccellati.—Meteorological observations taken at the Brera Observatory during the month of January.

February 12.—On the psychological act of *attention* in the animal series, by E. T. Vignoli.—On S. Grimaldi's project of an agrarian credit as a remedy for existing evils among the agricultural classes in Italy, by P. Manfredi.—On a class of configurations of the third power, by Prof. G. Jung.—On the geometrical movement of invariable systems, by Prof. C. Formenti.—On an integer more general than that of living forces for the movement of a system of material points, by Dr. G. Pennacchietti.—Integration of the differential equation $\Delta^2 u = 0$ in some very simple planes, by Prof. G. Ascoli.

Sitzungsberichte der Naturwissenschaftlichen Gesellschaft Isis, Dresden, 1884.—The organs of smell in the articulated animals, by Dr. Kraepelin.—An account of the Papuan inhabitants of Aru, Eastern Archipelago, communicated in a private letter to H. Engelhardt.—On *Anguillula radicicola*, a parasite infesting the coffee-plant on the Brazilian plantations, by B. Frank.—Phytological observations made on the flora of Dresden during the years 1883 and 1884, by A. Wobst.—On the morphology of the orchids, by Dr. O. Drude.—On the diluvial fauna of the Prohlis district, by Dr. Geinitz.—Remarks on some rare crystals of zircon and pyrites from Cornwall and Ontario, Canada, by A. Purgold.—On some archæological objects from Saxony, the Harz, and Italy, apparently connected with superstitious practices, by H. Wiechel.—On the chemical constitution of the colouring substance known as methylic blue, by Dr. R. Möhlau.—Memoir on new and little-known bird's eggs and nests from the Eastern Archipelago, specimens of which are possessed by the Dresden Zoological Museum, by A. B. Meyer.—On the latest geological researches in North America, by Dr. H. B. Geinitz. Remarks on the crepuscular phenomena observed in Europe and elsewhere at the end of the year 1883 and beginning of 1884, by Prof. G. A. Neubert.

Rivista Scientifico-Industriale, January 31.—Influence of static electricity on lightning conductors (concluded), by Prof. Eugenio Canestrini.—On the Westinghouse compressed air continuous brake, by the Editor.—Improved method of preserving ornithological specimens, by Dante Roster.

SOCIETIES AND ACADEMIES

London

Royal Society, March 5.—"On the Atomic Weight of Glucinum (Beryllium)." Second Paper. By T. S. Humpidge, Ph.D., B.Sc., Professor of Chemistry in the University College of Wales, Aberystwyth. Communicated by Prof. E. Frankland, F.R.S.

This paper is a continuation of one previously communicated to the Royal Society (*Proc. Roy. Soc.*, vol. xxxv. p. 137). The author has prepared a sample of metallic glucinum, having the composition—

Gl	99·20
GlO	0·70
Fe	0·20
	100·00

and has determined its specific heat at varying temperatures up to 450° with the following results (for pure glucinum) :—

c_{100}^{11}	0·4286
c_{145}^{13}	0·4515
c_{193}^{11}	0·4696
c_{240}^{15}	0·4885
c_{312}^{14}	0·5105
c_{360}^{11}	0·5199
c_{447}^{17}	0·5403

These results correspond to the following empirical formula for the true specific heat of the metal at varying temperatures—

$$k_t = k_0 + 2\alpha t + 3\beta t^2,$$

or with numerical values—

$$k_t = 0{\cdot}3756 + 0{\cdot}00106t - 0{\cdot}00000114t^2,$$

whence the following values for k_t are calculated :—

k_0	0·3756
k_{100}	0·4702
k_{200}	0·5420
k_{300}	0·5910
k_{400}	0·6172
k_{500}	0·6206

If these values are graphically represented the curve so obtained reaches a maximum at about 470°, and then falls; but whether it represents the specific heat at higher temperatures than 500° is doubtful. The specific heat of glucinum thus rises rapidly up to about 400°, and remains approximately constant between 400° and 500° at 0·62. If this number is multiplied by 9·1 it gives the atomic heat 5·64. Glucinum, therefore, belongs to the same class as carbon, boron, and silicon, which agree with Dulong and Petit's rule at high temperatures only. And the true atomic weight is that required by the periodic law—viz. 9·1 and not 13·6, as was previously deduced from the specific heat between 10° and 100°.

This conclusion is confirmed by the author's determinations of the vapour-densities of glucinum chloride and bromide in a platinum vessel. The experiments were done in an atmosphere of carbonic acid collected over mercury after Meier and Crafts (*Berlin. Ber.*, xiii. 851), and gave the following results :—

I. *Glucinum Chloride*

	Substance	Displaced CO_2	t	d
Experiment i. ...	26·4 mgrms. ...	7·47 c.c. ...	635° ...	2·733
,, ii. ...	28·0 ,, ...	7·98 ,, ...	785° ...	2·714

The theoretical density of $Gl''Cl_2$ is 2·76, and this formula, therefore, represents the molecule of this compound.

II. *Glucinum Bromide*

	Substance	Displaced CO_2	t	d
Experiment ii. ...	35·9 mgrms. ...	4·28 c.c. ...	608° ...	6·487
,, iii. ...	61·1 ,, ...	7·53 ,, ...	630° ...	6·276
,, iv. ...	26·0 ,, ...	3·22 ,, ...	606° ...	6·245

The density of $Gl''Br_2$ is 5·84, and that of $Gl'''Br_3$ is 8·76. The agreement in this case is not so close as in the case of the chloride, but is sufficiently near to show that the true molecular formula is $Gl''Br_2$, and not $Gl'''Br_3$. Thus, the vapour-density of both compounds necessitates the atomic weight 9·1. The result is a striking argument in favour of the value of deductions drawn from the periodic law in regard to the atomic weight of an element, and shows that such deductions will in future form one of the most important factors in fixing a doubtful atomic weight. The author did not appreciate the full value of the periodic law when he wrote his former paper, otherwise he would probably have stated his conclusions less positively.

Zoological Society, March 3.—Prof. W. H. Flower, F.R.S., President, in the chair.—Dr. E. Hamilton made some remarks on the supposed existence of the Wild Cat (*Felix catus*) in Ireland, as stated at a former meeting, observing that there was no record of the Wild Cat being indigenous to that country. Dr. Hamilton believed that the cat shown at the meeting in question was only the offspring of domestic cats born and bred in the woods of that district.—A letter was read from Mr. J. H. Thomson, C.M.Z.S., giving the locality of *Helix* (*Hemitrochus*) *filicosta*, which had been previously unknown.—Dr. A. Günther, F.R.S., exhibited and made remarks on the skin of a singular variety of the Leopard which had been obtained in South Africa. The back in this specimen was black, and the tail reddish gray, while the usual characteristic spots of the ordinary leopard were nearly altogether absent.—Mr. H. H. Johnston, F.Z.S., gave a general account of the principal animals observed by him during his recent journey to Kilimanjaro and his stay on that mountain.—Mr. Oldfield Thomas read a report on the Mammals obtained and observed by Mr. Johnston during his expedition.—Capt. G. E. Shelley read a report on the birds collected by Mr. H. H. Johnston in the Kilimanjaro district. The collection contained examples of fifty species, six of which were believed to be new to science.—Mr. Charles O. Waterhouse read a paper on the insects collected on Kilimanjaro by Mr. H. H. Johnston, and gave the descriptions of six new species of Coleoptera, of which examples occurred in the collection.—Prof. F. Jeffrey Bell read a description of a Nematoid Worm (*Gordius vermcosus*) obtained by Mr. Johnston on Kilimanjaro, which was found to be parasitic on a species of *Mantis*.—Mr. E. J. Miers communicated the description of a new variety of River-Crab of the genus *Thelphusa* (*T. depressa*, Krauss, var. *Johnstoni*), which had been obtained by Mr. H. H. Johnston in the streams of Kilimanjaro.—Mr. Francis Day read the fourth of the series of his papers on races and hybrids among the Salmonidæ, continuing the account of the Howietown experiments from November, 1884, to the present time.—Prof. Ray Lankester read some notes on the heart described by Sir Richard Owen in 1841 as that of *Apteryx*, and came to the conclusion that the heart in question was that of an *Ornithorhynchus*.

Chemical Society, February 19.—Dr. W. H. Perkin, F.R.S., President, in the chair.—The President announced that Mr. Warren de la Rue, F.R.S., had presented a bust of the late Prof. Dumas. The following papers were read:—On benzoylacetic acid and some of its derivatives, part 2, by Dr. W. H. Perkin, jun.—On toughened filter-paper, by E. E. H. Francis.—The detection and estimation of iodine, by Ernest H. Cook, B.Sc. (Lond.).—Note on methylene chlor-iodide, by Prof. J. Sakurai.—A quick method for the estimation of phosphoric acid in fertilisers, by J. S. Wells, Columbia College.—On the luminosity of methane, by Lewis T. Wright, Assoc.M.Inst.C.E.—On the oxides of nitrogen, by Prof. W. Ramsay and J. Tudor Cundall. In this research it is shown—(1) That the green or blue liquid obtained by the action of arsenious anhydride on nitric acid consists of a mixture of nitrous anhydride and nitric peroxide, in proportions depending on the strength of the nitric acid and the temperature at which the volatile liquid is condensed. (2) That if a dehydrating agent, such as sulphuric acid, be present in sufficient quantity the distillate consists of pure peroxide, and that this process is by far the most convenient one for the preparation of the peroxide. (3) That if oxygen be passed over the blue liquid, the vapours condensed in a freezing mixture are still blue or green; a great excess of oxygen is necessary to effect conversion from nitrous anhydride into peroxide. (4) That when excess of nitric oxide is passed along with the peroxide into a cooled bulb, the trioxide is produced, the amount of trioxide depending on the temperature of the condenser. (5) Vapour-density of a liquid of a deep blue colour, containing about 30 per cent. of trioxide and 70 per cent. of peroxide, shows that the trioxide cannot exist in the gaseous state, but at once dissociates into nitric oxide and peroxide on changing to gas. The theoretical vapour-density of such a mixture was calculated from a formula deduced from the second law of thermodynamics by J. Willard Gibbs, which shows the relations between temperature, pressure, and vapour-density of the mixture of NO_2 and N_2O_4 in the gaseous peroxide; and it was found that the vapour-densities of a mixture of (NO_2 + N_2O_4) (partly present in the original liquid as peroxide, partly formed by the decomposition of the N_2O_3 present into NO and (NO_2 + N_2O_4)) with the NO produced by the decomposition of the N_2O_3, calculated by means of Gibbs' formula, are identical, within limits of experimental error, with those obtained by direct experiment. (6) The presence or absence of moisture does not appear to affect the reaction between NO and O_2. (7) It is probable that N_2O_3 undergoes dissociation with rise of temperature, even while liquid.—Discussion:—Dr. Armstrong said that he had listened to the paper with great interest, as he had made numerous experiments on the subject, and had long been of opinion that N_2O_3 did not exist, at all events as gas. The authors' observations, whereby they were led to this conclusion, were of considerable importance, and it was to be hoped that ere long confirmatory evidence that would more directly appeal to chemists would be forthcoming. It was noteworthy that there was no recorded evidence proving the existence of N_2O_3 as gas. Gay-Lussac's experiments, published in 1816, showed that nitric oxide and oxygen only reacted in the proportions to form N_2O_4, and that reactions in proportions corresponding with the production of N_2O_3 only took place in presence of alkali. The method adopted by the authors did not suffice to prove the existence of N_2O_3, even as liquid, and the results could be equally well interpreted on the assumption that they were dealing with a solution of NO in N_2O_4. It was to be expected that N_2O_4 would be a good solvent of NO, as it appeared to be the rule that bodies which are related are easily miscible, phosphorus, for example, being very soluble in PCl_3, and sulphur in CS_2 and S_2Cl_2. One observation made by the authors did, however, support their view, viz. the observation that the blue liquid was with great difficulty oxidised by passing oxygen into it. In all his experiments, Dr. Armstrong had found that the reactions attributed to N_2O_3 could be equally well affected by a mixture of N_2O_4 and NO. As to the action of arsenious oxide on nitric acid, in his opinion, *nitrous acid* was *the* product, and the manner in which this underwent change entirely depended on the conditions. In dilute solution, NO would be produced in accordance with the equation: $3HNO_2 = 2NO + HNO_3 + H_2O$; but in presence of nitric acid the reaction $HNO_2 + HNO_3 = N_2O_4 + H_2O$ would take place, and would more and more preponderate the less the amount of water present. The addition of sulphuric acid would of necessity favour the latter mode of change. When N_2O_4 is passed into sulphuric acid, nitrosyl sulphate and nitric acid are formed; in presence of NO the latter is reduced to nitrous acid which also forms nitrosyl sulphate with the sulphuric acid, so that a mixture of NO and N_2O_4 in proper proportions precisely acts as though it were N_2O_3.

Anthropological Institute, March 10.—Francis Galton, F.R.S., President, in the chair.—The election of G. F. Legg was announced.—Mr. James G. Frazer read a paper on certain burial customs as illustrative of the primitive theory of the soul. The Romans had a custom that when a man who had been reported to have died abroad returned home alive, he should enter his house, not by the door, but over the roof. This custom (which is still observed in Persia) owed its origin to certain primitive beliefs and customs with regard to the dead. The ghost of an unburied man was supposed to haunt and molest the

living, especially his relatives. Hence the importance attached to the burial of the dead; and various precautions were taken that the ghost should not return. When the body of a dead man could not be found, he was buried in effigy, and this fictitious burial was held to be sufficient to lay the wandering ghost, for it is a principle of primitive thought that what is done to the effigy of a man is done to the man himself.—The director read a paper by Admirel F. S. Tremlett, on the sculptured dolmens of the Morbihan. About eighty sculptures had been found, invariably on the interior surfaces of the cap-stones and their supports. It is remarkable that they are confined within a distance of about twelve miles, and are all situated near the sea-coast, beyond which, although the megaliths are numerous, there is a complete absence of sculptures. The sculptures vary in intricacy from simple wave-lines and cup-markings to some that have been compared to the tattooing of the New Zealanders.

Geological Society, February 25.—Prof. T. G. Bonney, F.R.S., President, in the chair.—Bennett Hooper Brough, Parvati Nath Datta, Robert Stansfield Herries, William Herbert Herries, Rev. Edward Jordon, Lees Knowles, and William Hobbs Shrubsole were elected Fellows of the Society.—The following communications were read:—On a dredged skull of *Ovibos moschatus*, by Prof. W. Boyd-Dawkins, F.R.S.—On fulgurite from Mont Blanc, by Frank Rutley, F.G.S.—On brecciated porfido-rosso-antico, by Frank Rutley, F.G.S.—Fossil Chilostomatous Bryozoa from Aldinga and the River Murray Cliffs, South Australia, by Arthur Wm. Waters, F.G.S. The seventy three fossils described in the present paper were collected by Prof. Ralph Tate, and, with a few exceptions, are from Aldinga and the River Murray Cliffs, Australia. This collection again furnishes interesting cases of species growing in both the Eschara and the Lepralia form; but the chief interest is in a number of specimens which grow in a "cupulata" manner, thus in the mode of growth resembling *Lunulites*. Attention was again called to the fact that, though the shape and nature of the zooecial avicularia (onychocellaria) are characters of the greatest value, yet their presence or absence cannot be made a specific distinction, as there are a large number of cases where specimens are found with none or only a few such avicularia, whereas on other specimens of the same species, collected under similar circumstances, they may occur abundantly over the whole colony, or in parts of the colony, in large numbers. In the *Challenger* Report, Mr. Busk refers to a slender process rising from the middle of the base of the avicularian mandible, and names it "columella." This he considers only occurs in one division of the *Celleporæ*, and in this division only in those belonging to the southern hemisphere. This was shown to be by no means the case, as it is found in the mandibles of *Cellepora sardonica* from the Mediterranean, in two other common Mediterranean *Celleporæ*, &c. In many species there is a denticle in this position rising from the calcareous bar which divides the avicularium. This denticle occurs in various genera and species, and may often be found a useful specific character when examining fossils. Out of the 220 species now described in this series of papers, just about one-half are now known living. The species noticed in this paper are seventy-three in number, referred by the author to the genera *Cellaria, Membranipora, Micropora, Monoporella, Steganoporella, Cribrilina Mucronella, Microporella, Lunulites, Porina, Lepralia, Smittia Schizoporella, Mastigophora, Retepora, Rhynchopora, Cellepora, Lekythopora*, and *Selenaria*. Five species are described as new, namely, *Microporella pocilliformis, Lepralia confinita, Cellepora biradiata, Schizoporella protensa*, and *Membranipora temporaria*.

Victoria Institute, March 16.—Mr. W. P. James read a paper on the relation of fossil botany to theories of evolution, in which he gave a *résumé* of the whole question with which his paper dealt.

EDINBURGH

Mathematical Society, March 13.—Mr. George Thom, Vice-President, in the chair.—Mr. George A. Gibson read a paper on Gilbert's method of treating tangents to confocal conicoids.—Mr. J. S. Mackay gave an account of Schooten's geometry of the rule.—Mr. A. Y. Fraser read a note by Mr. P. Alexander on two definite integrals.

PARIS

Academy of Sciences, March 9.—M. Bouley, President, in the chair.—Obituary notices of the late M. J. A. Serret, Member of the Section for Geometry, by MM. Jordan, Bonnet, Faye, and Renan.—Methods of observing the polar stars at a great distance from the meridian, with a table containing the corrective term intended to facilitate the reductions, by M. M. Lœwy.—Bromuretted substitutions of the polyatomic phenols, by MM. Berthelot and Werner. Here the authors deal with resorcine ($C_{12}H_6O_4$) and orcine ($C_{14}H_8O_4$) diatomic phenols, each of which furnishes a tribromuretted substance capable of being employed in their quantitative analysis.—On the decomposing action exercised by the chloride of aluminium on certain hydrocarburets, by MM. C. Friedel and J. M. Crafts.—Report on the new gallery of palæontology in the Paris Natural History Museum, by M. A. Gaudry. This gallery, which has been fitted up in the Whale Court, contains specimens of *Megatherium Cuveri, Elephas meridionalis, Mastodon augustidens, Cervus megaceros, Testudo elephantina, Pelagosaurus typus, Palæotherium magnum*, and some other gigantic extinct animals.—Observations of the planet 245, discovered by M. Borrelly at the Observatory of Marseilles, by M. Stephan.—On some anomalies in the phenomenon of tides in connection with M. Hatt's work, by M. de Jonquières.—Report on the International Congress of Washington, and on the resolutions there adopted respecting the first meridian, the universal hour, and the extension of the decimal system to the measurement of angles and of time, by M. J. Janssen, representative of France at the Congress. The report, which is partly occupied with M. Janssen's address objecting to Greenwich, and advocating a neutral first meridian at the Azores or Behring's Straits, concludes with the words: "However this be, and apart from the question of the meridian, which is not yet decided, let us not forget that the accession of England to the convention for the metrical system and the wish expressed for its general extension are important results, showing that our presence in Washington has not been useless either for science or progress."—Report on M. Léauté's memoir on oscillations at long intervals in machines propelled by hydraulic action, and on the means of preventing those oscillations, by M. Phillips.—Observations of Encke's comet made at the Observatory of Paris (equatorial coudé), by M. Périgaud.—Spectroscopic studies, by M. Ch. V. Zeuger. The author submits a method for clearing from the field of vision all rays except those lying nearest to the C band, and for thus observing, by means of the parallelopiped of dispersion, the protuberances proper to hydrogen under the monochromatic red light.—A method of avoiding the dangers incident to mechanical generators of electricity: reply to M. Daussin's claim to priority of invention, by M. A. d'Arsonval.—Study of the means employed to take the potential of the atmosphere: electromotor force of combustion, by M. H. Pellat.—On the decomposition of salts by water, by M. H. Le Chatelier. The author, against the generally-accepted views, formulates and demonstrates the two following propositions:—(1) The quantity of free acid required to resist the decomposition of a salt in solution increases indefinitely with the proportion of the salt contained in the fluid; (2) the decomposition of a salt in solution increases or diminishes with the changes of temperature, according as this decomposition absorbs or liberates heat.—On the separation of titanium from niobium and zirconium, by M. Eug. Demarçay.—On the normal pyrotartaric and succinic nitriles ($CN-(CH_2)-CN$; and $CN-(CH_2)_2-CN$), by M. Louis Henry.—On the preparation, properties, and reactions of iodacetone, by MM. P. de Clermont and P. Chautard.—Heat of formation of the glyonal bisulphide of ammoniac, by M. de Forcrand.—Researches on the colouring matters of leaves; identity of the orange-red matter with carotine, $C_{18}H_{24}O$, by M. Arnaud.—On the analogies with and differences between the genus Simœdosaurus of the Cernay fauna, Rheims district, and the genus Champsosaurus of Erguelinnes, by M. V. Lemoine.—Underground rumblings heard on August 26, 1883 (date of the Krakatoa eruption), at the island of Caiman-Brac, Caribbean Sea, 20° N. lat., 85° E. long., by M. F. A. Forel.—Remarks on the three first numbers of Rossi's decennial *Bulletin* of the Observatory and central geodynamic Archives of Rome, by M. Daubrée.

BERLIN

Physical Society, February 6.—Dr. König communicated an experiment he had carried out in conjunction with Dr. Richarz, with a view to testing the ground of a misgiving expressed at a recent meeting of the Society in connection with a plan he had set forth for the purpose of determining the constants of gravitation (*vide* NATURE, vol. xxxi. p. 260). It was maintained that the lead block of 2000 centners would, on

account of its weight, become extended at its base and consequently change its form—a circumstance which would prove very prejudicial to the experiments contemplated in connection with it. Dr. König and Dr. Richarz had, therefore, calculated the pressure exercised by the lead mass, which should have a basal plane of 1·9 square metres, on the square centimetre, and had found it equal to 2·3 kg. They then prepared a small lead cylinder, placed it with due underlayers on the earth, and by means of pulleys and weights caused a constant pressure of more than 6 kg. per square centimetre to be exerted on its smooth upper surface. Two fine steel spikes were fastened in the side of the lead mass, and their distance from each other exactly measured. After this pressure had been exerted for a considerable length of time on the lead, the distance of the two steel spikes from each other was again determined, and all the displacement which had occurred was found to be but 0·01 mm., an amount which might very well have been caused by differences of temperature. At all events it was so trifling, that in the case of a pressure three times less, such as would be that of the large lead mass utilised in the quantitative experiment, no deformation due to its own weight was to be apprehended.—Dr. König further reported on measurements of colour-sense and visual acuteness effected by him on a number of Zulus at present staying in Berlin. Their colour-sense was tested by means of the leucoscope. On the turning of the Nicol prism the savages stated distinctly that the colours of the two images became even more similar to each other, and at last almost alike, and that, on a further turning of the Nicol prism, the colours came to vary more and more from each other. The colour-sensibility of the savages was, therefore, equal to that of the normal eyes of civilised peoples. They distinguished with exactness, and denoted by different names the colours red, yellow, blue, brown, black, and white. While they distinguished as red only the purest spectral red, they denoted as yellow or as blue all objects having any yellowish, or, on the other hand, any bluish tinge. As "grass colours" they called the green, and violet they named after a mineral unknown to Dr. König. The unsaturated colours they defined by affixing a syllable to the name of the particular colour in each case, an affix signifying much the same as "young." The visual acuteness was measured by means of Snellen's writing tests, according to which the smallest characters used, when distinctly seen at a distance of 6·5 m., was equal to 1. From extensive statistical investigations in Germany the visual acuteness of a perfectly normal eye was found to average 1·75. The measurements taken with male Zulu adults showed, on the other hand, that they were able to recognise with certainty the smallest written characters at a distance of from 24 m. to 25 m.; a Zuly boy of about eight years showed a visual energy of only 1·50; and a Zulu woman a still lower value of visual force—a result which was, however, to be explained by the circumstance that the woman was squint-eyed, and had, moreover, clearly-ascertained obscurations of the cornea.—Following up this address, Dr. König intimated that, in the Physical Institute, experiments had been made by Dr. Uhthoff on the influence of light intensity on visual acuteness. From a large number of experiments it appeared that if the light intensity was taken as abscissa, and the degrees of visual acuteness appertaining to it as ordinates, then the resulting curve, in the case of the greatest visual acuteness answering to a good full illumination by day, ran parallel to the axis of the abscissa, falling, at first slowly and then rapidly, towards the null point. The mode of the sinking of the curve was different with different individuals. Under low light intensities differences occurred as much as 1 to 2. The visual energy became null shortly before the light intensity was null. In this respect likewise, however, there were differences in the case of different individuals, those possessing a greater acuteness of vision showing the visual energy at the null point under a greater light intensity than in the case of such persons as had a lower acuteness of vision, in whom the curve began nearer the null point of the abscissa. Normal eyes with greater acuteness of vision, under the highest light intensities attainable by means of a petroleum lamp, showed symptoms of dazzlement, and the curve sank to the axis of the abscissa. In the case of the eyes of much less visual acuteness the curve, even under these highest intensities, continued still parallel to the abscissa. In the discussion which this address gave rise to, Prof. von Helmholtz brought out and established, by entering into detail, that it was altogether unjustifiable to assume that the ancients had not such developed colour-sense as recent persons, and that this assumption was an inference quite unwarrantably drawn from the mere defect of names for the different colours.

February 20.—Dr. Kayser referred to a method published by M. Wolf in the *Comptes Rendus* for measuring the velocity of light, which differed from Foucault's experiment inasmuch as the rotating mirror was concave and the aperture admitting the light was a small transparent spot in a larger concave mirror. By Wolf's method the displacement of the reflection of the light could be made to reach as much as 1 m., and could be easily measured with precision.—Prof. Neesen made some communications respecting an investigation, which was not yet concluded, into Geissler's tubes. In an older tube with aluminium electrodes he found that the process of evacuation, up to the highest degree of rarefication, at which the electricity no longer passed through the tube, was rendered more difficult if continuous electric discharges were sent through the tube, but, on the other hand, was very easy when no electric current was transmitted. If, with high degrees of rarefication, phosphoric light filled the glass ball, a black precipitate was regularly formed on the glass, which disappeared on the admission of a small quantity of air into the tube. If the tube was put in communication with an electric lamp, and the carbon thread, after being kept in a glowing state for about an hour, was allowed to cool, a complete vacuum was more easily obtained, probably because the gaseous substances adhering to the glass were absorbed by the carbon. In such a case it was of no consequence for the evacuation whether a discharge was transmitted continuously through the tube or not. The phosphoric light, after the absorption by the carbon-thread, was likewise changed. Instead of being yellow and filling up the whole ball, it was rosy, limited, and soon disappeared. If the tube was then for some time exposed to the air and evacuated, yellow phosphoric light and the black precipitate again appeared. Prof. Neesen was of opinion that the process of phosphorescence was induced by substances which were absorbed by the glass and decomposed by the electric light, and that the black precipitate was a product of this decomposition.—Dr. Sklarck referred shortly to the measurement of the propagation velocity of electricity in telegraph wires, which Prof. Hagenbach, in Basel, had carried out according to a new method.

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THURSDAY, MARCH 26, 1885

PRACTICAL PHYSICS

Practical Physics. By R. T. Glazebrook, M.A., F.R.S., and W. N. Shaw, M.A., Demonstrators at the Cavendish Laboratory, Cambridge. (London: Longmans, Green, and Co., 1885.)

THE authors have done a real service to all whose business it is to conduct classes in a physical laboratory by supplying them with a most excellent guide. Not only teachers, but students, will find this book invaluable.

The authors have for some time prepared manuscript notes for use in the laboratory, sufficient to enable a student to make the measurements described without that frequent necessity for supervision which is found when verbal instruction only has been given. Since such well tested notes form the main portion of this work, it is certain that the experiments which are described have been so frequently carried out that the details given are sure to correspond to the best arrangement in each case, and further, that all possibility of an oversight has been removed.

In many cases instruments used for the same purpose are so different in d tail that the authors were met by the difficulty of choosing whether to describe several forms or to be content with explaining the particular instrument used for each purpose at the Cavendish Laboratory. They have, in adopting the latter course, found one means of limiting an enormous subject. In another direction they have found a natural boundary—that between a book of theoretical and one of practical physics. The theory of the methods and instruments is not given at length, except in those cases where the text-books are not sufficiently explicit. Again, the whole range of practical physics is so extensive that choice had to be exercised as to what experiments should be included and what unavoidably passed by. The experiments selected in each subject are typical, and are such as "to enable the student to make use of his practical work to obtain a clearer and more real insight into the principles of the subjects; they include those which have formed for the past three years the course of practical physics for the students preparing for the first part of the Natural Sciences Tripos." It would be impossible to make a selection more exactly suited to meet the wants of an educational laboratory.

In the preface will be found the system employed at the Cavendish Laboratory for making a set of apparatus go as far as possible with a large class. The subject is divided into sections, each requiring its own instruments; sometimes one, sometimes several, experiments belong to one section. When any section is assigned to a student, none of the instruments belonging to it are available elsewhere. The same system of division is employed in the text, no less than eighty-two numbered sections being the result.

The value of the book is much enhanced by the addition, at the end of each section, of the results of an actual experiment. These short statements are valuable in many ways. In the first place, they show how to enter results systematically, so that the meaning of the entry is obvious. Secondly, they show the probable degree of accuracy attainable, especially when more than one method of making the same determination is given. Thirdly, and this is perhaps the most important to the teacher, the series of numbers to be found enables any one to discover the proportions and sizes of the several parts of each piece of apparatus employed. An example taken from p. 420 will make this clear:—

"*Experiment.*—Determine the difference of potential between the two ends of the given wire through which a current is flowing. Enter results thus:—

	grms.
Mass of water	24·2
Water equivalent of the calorimeter ...	4·2
m	28·4
M (copper deposited in voltameter)...	·222

Total rise of temperature for each two minutes:—

4°·4 4°·4 4°·2 4°·0 3°·8

T ... ... 24°·8

$E = 4·36 \times 10^8 = 4·36$ volts."

In this case there is no means of estimating the probable accuracy of the result, but the data are sufficient to enable any one who wishes to do so to reproduce exactly the instrument employed.

The chapter on physical arithmetic, in which errors, corrections, accuracy, and the manipulation of small quantities are treated, is of special value.

The chapter on the balance is very complete. Though perhaps the balance is the most important of all philosophical instruments, it is a question whether so much space as twenty pages should be devoted to it, where so much that is important is necessarily excluded for want of space. Students do certainly use the balance most blindly, and if its theory is not explained in a satisfactory manner in the text-books, this surely is the place to find it. Other subjects of which the usual accounts in the authors' opinions needed supplementing are measurement of fluid pressure, thermometry, calorimetry, and hygrometry.

The chapters on electricity and magnetism are treated in a different manner from the rest of the book, for what reason is not apparent. The precise and quantitative relations between mechanical, magnetic, and electrical units are to be found in almost every modern text-book, and so there would be no occasion to repeat definitions, &c., if the treatment of these last chapters was the same as that employed in the earlier ones. It is here perhaps more than anywhere that the authors had to exercise their choice of the most suitable, out of an almost endless variety of experiments, any one of which might well find a place. No one can find fault with the selection, yet it seems a pity that not a word is said about electrometers or indeed about statical electricity at all. Many will be disappointed in finding no account of the absolute determination of electromotive force by any of the methods of induction. The only method given depends on the measurement of the heat generated by a current, which of course involves a knowledge of the value of J, the mechanical equivalent of heat. This is the more to be regretted, as instructions for determining experimentally the value of J are not to be found in the chapter on heat. It is to be hoped that in another edition a few pages will be devoted to one or both of these essential measurements.

For a first edition the book is remarkably free from

misprints, the only one discovered being the omission of a "π" in the denominator of the expression for the absolute capacity of a condenser (p. 480). C. V. B.

MALAYAN ANTIQUITIES

Alterthumer aus dem Ostindischen Archipel und Angrenzenden Gebieten. Herausgegeben von Dr. A. B. Meyer. (Leipzig, 1884.)

THE present sumptuous volume forms the fourth of the series being issued under the enlightened management of the Curator of the Dresden Zoological and Anthropological Museum. These costly publications, which could scarcely be undertaken without the active co-operation of the general administration of the royal artistic and scientific collections in the Saxon Capital, will, when completed, prove a great boon, especially to students of eastern antiquities, and of the progress of human culture amongst the peoples of Southern Asia.

This fourth part, so far complete in itself, will be found of great value in elucidating the civilising influences both of Brahmanism and Buddhism on the races of Further India and the Malay Archipelago. It comprises nineteen photographic plates in folio, four of which are exquisitely coloured, with explanatory text and a map devoted almost exclusively to this important subject. Thus we have here embodied at once a descriptive and illustrated record of the archæological treasures in the Dresden Collection, which serve to mark the progress of the arts in the Eastern Archipelago and neighbouring regions from the earliest historic period, that is, from the first contact of those lands with the Indian religious and artistic world.

The arrangement is thoroughly systematic and most convenient for purposes of reference and comparative study, objects in stone, metal, wood, porcelain, and allied materials being grouped separately, and dealt with in the order indicated. The four stone figures from Java, reproduced on the first two plates, show at once the advantage of this arrangement. Here we have on Plate I. a genuine Brahmanical Trimurti placed side by side with a full-breasted female figure of undoubted Buddhistic type; on Plate II. an unmistakable Brahmanical Siva, again contrasted with the representation in high relief of two men, who, from their devout attitude and other indications, are evidently of Buddhist origin. Taken collectively these two groups thus present a striking illustration of both streams of Hindu culture, by which the island of Java was successively flooded. On this point the Curator's remarks in the accompanying text are highly instructive:—

"The Hindu antiquities found in Java are either Brahmanistic, Buddhistic, or mixed. Brahmanism repeatedly occurs in its Sivaistic phase. Buddhism, pure only in Borobudur and Tyandi Mendut ('Veth,' Java, ii. 172), is found mixed with Sivaism, Sivaistic divinities sometimes surrounding images of Buddha (Leemans, 'Borobudur,' 444), Buddhistic figures at others encircling Sivaistic idols ('Veth,' ii. 103, 173), or else assuming monstrous forms, such as often characterise Brahmanical deities ('Veth,' ii. 96, and Max Uhle, 'Descriptive Catalogue in MS. of the Royal Ethnological Museum,' No. 1464)."

The greatest monuments of Buddhism appear to be concentrated mainly in the central parts of Java, while those of the Brahmanical cult are scattered round them in all directions. Extensive Brahmanical settlements had already been formed in the island long before the first arrival of the Buddhist missionaries, who, according to Dr. Meyer, made their appearance probably about the fifth century of the new era. The stupendous Buddhist temple of Borobudur, rivalling that of Angkor-Vaht in Camboja, is assigned to the eighth or ninth century. But no attempt has been made to determine the date of the earliest Brahmanical remains in Java or the other islands of the Archipelago. They cannot, however, be much more recent than the first century of the Christian era, and may possibly be some two or three centuries earlier. It is to be regretted that this point cannot be determined with some approach to accuracy, for it has obviously a most important bearing on the question of the migrations of the Indonesian races, and especially on the diffusion of the Malayo-Polynesian languages throughout the Indian and Pacific Oceans. Those writers, who are disposed to regard these as comparatively recent events, should at least bear in mind that there are practically no traces of Sanskrit or Prakrit elements either in Malagasy, or in any of the Eastern Polynesian dialects. Hence, if Malaysia be taken as the point of dispersion west to Madagascar, east to the South Sea Islands, the migrations must necessarily have taken place at some time before the spread of Hindu influences throughout the Eastern Archipelago.

However, the collection is not confined to Hindu subjects, and on Plate VII. are figured a large number of iron spear-heads, some of which are undoubtedly subsequent to the introduction of Islám in the thirteenth century. Many of these objects, which were found in Jokjokarta (Java), are of simple type, much corroded by rust, and no doubt of considerable antiquity. But others show distinct traces of damaskeening, an art unknown before the arrival of the Arabs, although now universally diffused throughout the Archipelago. The process, locally known by the name of *pamor*, consists in manipulating steel and iron by means of acids, the designs being inlaid by the priests (Pfyffer, "Sketches from Java," p. 32).

Conspicuous among the bronze objects is a magnificent lion's head of absolutely unique type and great size (compass round neck 34 cm., diameter 30 cm., weight 100 kilograms), apparently from Camboja, although first discovered in Java. This superb bronze, whose analysis yielded copper 92·49, tin 5·53, lead 1·40, cobalt and nickel 0·07, iron 0·12, total 99·61, is referred by Dr. Meyer to the flourishing period of Cambojan art as embodied in the monuments of Angkor Vaht, and would accordingly be some 600 or 800 years old. Front and side views are here given in half the natural size on two separate plates. From these it is evident that the lion is playing the part of a rakshasa or guardian to some Buddhist shrine, such as are found sculptured at Borobudur. Another rakshasa of a very different character is a wooden figure of Garudha from the island of Bali, reproduced by the new phototype process, which has already rendered such valuable services to the arts, and especially to archæology in Germany. Here Garudha is represented as a winged human figure bearing on his shoulders probably a Vishnu, of whom the legs alone, suspended in front, have been preserved. It is described as perhaps a Sivaitic representation from some Brahmanical temple in Bali, where Vishnuism and Sivaism are said to be intimately associated. The introduction of the Hindu cult into Bali, where it still holds its

ground in the midst of Islám, is referred to the beginning of the fifteenth century. But the fair state of preservation of this wooden image bespeaks a much more recent date.

On the concluding plates are figured numerous designs of bronze drums or gongs from every part of the Archipelago and Further India. These instruments, which play so large a part in the social economy of the Indonesian and Indo-Chinese peoples, are here brought together for the purpose of elucidating the obscure and hitherto little studied history of their origin and diffusion throughout South-Eastern Asia. Those interested in the subject will find much instructive matter embodied in the accompanying text.

A word of thanks is also due to Dr. Max Uhle, the Curator's able assistant, not only for his general cooperation, but more especially for the great care he has bestowed on the map of the regions in question. On it are accurately indicated all the places in Malaysia where Hindu antiquities have at any time been discovered, or where monuments dating from pre-Muhammadan times are found. A. H. KEANE

OUR BOOK SHELF

The Antananarivo Annual and Madagascar Magazine, No. VIII. Christmas, 1884. (Antananarivo: Printed at the London Missionary Society's Press by Malagasy Printers.)

ALTHOUGH the previous number of this interesting periodical was, I believe, noticed in NATURE, I should like to call attention to the present issue, inasmuch as it is a token of the valuable scientific work which, amid great difficulties, is being bravely carried on by Christian missions in the sorely troubled island of Madagascar.

One of the editors of the *Annual*, the Rev. R. Baron, is an accomplished botanist, indefatigable in his efforts to explore the botany of his adopted home, and unwearied in his efforts to obtain materials for Mr. J. G. Baker and other workers at home; and his colleagues, no less than himself and his fellow editor, the Rev. J. Sibree, seem devoted to the double duty of teaching the Christian religion and civilisation to the Malagasy and of advancing our scientific knowledge of the strange land in which they are for the time being dwelling.

The present number, besides a spirited account of a Royal Kabary or coronation ceremony, contains valuable philological articles on the Malagasy pronouns, by the Rev. L. Dahle; on Malagasy dictionaries, by the Rev. W. E. Cousins; and on the want of new words in the Malagasy language and the way of supplying them, by the Rev. S. E. Jorgensen, the latter having a more than philological, indeed a personal, interest to scientific writers, who, like the Madagascar missionaries, are continually in "want of new words" and not always very judicious in their "way of supplying them." Articles on Malagasy superstitions, on the Sakaklava, and on Malagasy proverbs, contain much valuable matter for the anthropologist; while a paper on medical mission work, by a non-professional; an instructive critical exposure of a geographical fiction, by the Rev. L. Dahle; notes on natural history, by the Rev. R. Baron; a four years' record of rainfall, by the Rev. J. Richardson; and various notes, such as one recording the arrival, on Malagasy shores, of worn fragments of pumice-stone, supposed . o be from Krakatoa, complete the number.

The technical printing does great credit to the native printers, for, though one German quotation has gone a little wrong, the press errors are otherwise exceedingly few.

I feel sure that I may bespeak the sympathy of the readers of NATURE with the *Antananarivo Annual*, and that we may look forward with confidence to much scientific as well as other fruit from the continued labours of the editors and their *confrères*. M. FOSTER

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

The Forms of Leaves

I HAVE read Mr. Henslow's letter with interest; and of course any criticisms from him are worthy of all attention. At the same time I may observe that as yet he has only seen what may be called an abstract of an abstract. A Friday evening lecture is scarcely the occasion to work out a special statement in detail; but he is apparently criticising not even my lecture itself, but merely an abstract of it. He commences by saying that it is "self-evident" that the size of the leaf is regulated mainly by the thickness of the stem. This may be, but, so far as I am aware, the importance of this consideration had not been previously pointed out. Having, however, first disposed of my statement as "self-evident," he proceeds next to deny it altogether, and quotes cases in which the size of certain leaves bore no reference to the thickness of the stem. With regard to these, however, I must observe that I was referring to leaf-area, and as Mr. Henslow does not mention the number of leaves his illustration is incomplete. Moreover, as he was dealing merely with an abstract of what I said, he does not recognise the qualifications to which, in the lecture itself, I called attention.

As regards holly leaves, Mr. Henslow denies my statement, and questions my explanation. With reference to the fact, I should have thought there was no question. It has been stated over and over again in standard works. Sir J. D. Hooker in the "Student's Flora," for instance, says that the leaves are spinous, adding, those on the upper branches often entire." This is entirely in accordance with my own experience. Next, as to the explanation. Mr. Henslow observes that it "seems to be attributing to the holly a very unexpected process of ratiocination." Surely, however, this would apply to any explanation, and in this world there must be some cause for everything. Mr. Henslow would not maintain that the pitchers of pitcher plants imply any process of ratiocination?

Mr. Henslow's next point is with reference to fleshy leaves, and he observes that, "Surely the usual explanation that it is this thick cuticle which prevents rapid exhalation is a better reason." A better reason for what? I was not speaking of the thickness of the cuticle but of the unusual development of the parenchymatous tissue.

Again, he questions whether "cut-up" leaves present a greater extent of surface in proportion to their mass, but surely he cannot seriously deny this.

Lastly, he doubts whether it is an advantage to water-ranunculi to have filiform leaves, because he saw a pond last summer which was dried up, and yet covered with a "carpet composed of the erect filiform branchlets of the cut-up leaves of *Ranunculus aquatilis*." But it does not follow that a plant placed in an abnormal situation should at once alter its habit, any more than an individual duck would lose its webbed feet because it was kept from water. Any one who will take an ordinary plant of *R. aquatilis* out of water will see at once that the leaves cannot support themselves.

I admit that my suggestions require more evidence than can be given in a single lecture, and I shall hope to develop them at greater length elsewhere; but in the mean time, though I think that Mr. Henslow's criticisms admit of answer, I am much obliged for his suggestions. JOHN LUBBOCK

Aurora at Christiania

ON the evening of March 15 an aurora appeared of unusual proportions for our part of the country. It was seen for the first time at 7.45, and then consisted of diffused and faint arches high on the northern sky. By degrees its sphere extended, and

at 8.30 it reached the zenith. In this position—from the northern horizon to zenith—the phenomenon remained almost uninterrupted all the following time. The light was rather feeble, and in the beginning the motions were insignificant. But at 10 o'clock the peculiar blazing or undulating movement that is designated by the name of *coruscation*, began to be seen, and during four hours and a half at least the whole northern half of the sky was the theatre of this uncommonly violent chase of the luminous clouds. The culmination of the aurora happened at 10.30, when on the northern sky advanced a series of splendid streamers, the inferior points of which played in red and green. This radiance was only of short duration, and later there appeared in the north only arches more or less distinct; while on the higher parts of the heavens the chasing flames incessantly continued their playing. Still, so late as 14.30 saw the flames as far as to the zenith with unimpaired violence.

I may add that on this occasion I succeeded in what I myself, as well as other friends of the aurora, have tried before in vain, viz. *to get the aurora to make impression on a photographic plate*. I exposed in all five plates; of these four (for times of exposure of 2–4 minutes) without the least trace of action, but the fifth, which was exposed during 8½ minutes, shows both a part of the horizon with a high church spire and a feeble representation of a portion of the aurora. I must, however, state that this portion in itself was but very feebly illuminated, and that at the time when the phenomenon developed the greatest power of light I was prevented from applying the camera.

The object-glass employed was: Voigtländer euroscope, No. 1; Schleussner's dry plates.

Also on the 16th, in the evening, 8.45 to 10, there appeared an aurora, but consisting essentially only of feeble fragments of arches rather low on the northern sky. The aurora has in recent times been astonishingly rare: here in Christiania, in the course of the whole winter, it has been observed on the following days:—September 14, 17, 24; October 14, 15; November 17; December 22; January 22; February 14, 16; March 12, 15, 16.

March 15 excepted, all these auroræ have been rather insignificant. SOPHUS TROMHOLT

Christiania, March 17

"Peculiar Ice Forms"

UNDER the above caption, several correspondents of NATURE have recently described and discussed the agglutinated filamentoid ice-crystals commonly extruded from unfrozen earth under suitable conditions of moisture and temperature. B Woodd Smith records their occurrence in the Savoyan Alps (his language implying variety of the phenomena there), and attributes them to the linear expansion incident to congelation of capillary columns of water in a thin sheet of soil resting upon rock (vol. xxxi. pp. 5-6). W. alludes to such crystals in general terms, refers to a previous notice of similar phenomena, and (erroneously) allies them genetically to hoar-frost (*ib.*, p. 29). Dr. John Rae discusses distinct (but erroneously supposed similar) phenomena at length, and argues that the several strata of crystals are remnants of successive sheets of ice or snow (*ib.*, pp. 81-2). Mr. Smith then controverts Mr. Rae's explanation, maintains his own, and refers to several earlier communications in NATURE relating to filamentoid ice-crystals (*ib.*, pp. 193-4); and sebsequently he transmits a letter from John D. Paul, who has essentially repeated his own observations in the Alps (*ib.*, p. 264).

Now that it has become fashionable to revive forgotten records, it may be pointed out that these correspondents ignore the more valuable portion of the literature of their subject. Even in NATURE discussion of the fibrous ice-crystals extruded from moist earth, wet wood, &c., was epidemic fifteen years ago, and again ten years later, besides the sporadic cases of three years ago, as shown in the following bibliography:—

1870	Vol. I.	—C. Spence Bate	p. 556
,,	,,	—Mr. Pengelly	p. 627
,,	Vol. II.	—T. G. Bonney, John Langters (*sic*)	pp. 141-2
1871	Vol. III.	—T. G. Bonney, John Langton	pp. 105-7
,,	,,	—T. G. Bonney	p. 288
1880	Vol. XXI.	—Argyll	p. 274
,,	,,	—R. Meldola	p. 302
,,	,,	—Argyll	p. 368
,,	,,	—O. Fisher	p. 396
1880	Vol. XXI.	—D. Wetterhan	p. 396
,,	,,	—L. Bleekrode	p. 444
,,	,,	—S. T. Barrett	p. 537
,,	,,	—Wm. Le Roy Broun	p. 589
,,	Vol. XXII.	—John Le Conte	p. 54
,,	,,	—R. H.	pp. 145-6
1882	Vol. XXV.	—J. F. Duthie	p. 78
,,	Vol. XXVI.	—H. Warth	p. 81

The second outbreak was practically terminated by the communications of Profs. Broun and Le Conte. The first of these gentlemen wrote from a locality in which the phenomena are readily observable, while the latter called attention to his own elaborate researches of thirty years before (*Proc. Am. Assn. Adv. Sci.*, iii. 1850, p. 20-34; *Phil. Mag.*, third series, xxxvi. 1850, pp. 329-42).

More recently (February 6, 1884) Prof. Schwalbe has placed before the Physical Society of Berlin the results of his observations upon filamentoid ice-crystals in the Harz. After thorough study he accepts Le Conte's views as to their genesis.

Prof. Le Conte's explanation (which is essentially identical with that subsequently offered independently by Prof. Broun) is as follows:—"Let us suppose a portion of tolerably compact porous and warm earth saturated with moisture, to be exposed to the influence of a cold-producing cause. The soil being an imperfect conductor of heat, only a very superficial stratum would be reduced to the freezing point. As the resistance to lateral expansion is less at the surface than it is at] a sensible depth below, the effect of the first freezing would be to render the apices of the capillary tubes or pores conical or pyramidal. The sudden congelation of the water, filling the conical capillaries in the superior stratum, would produce a rapid and forcible expansion, which, being resisted by the unyielding walls of the cone, would not only protrude, but *project* or *detach and throw out* the thread-like columns of ice, in the direction of *least resistance*, or perpendicular to the surface. This would leave the summits of the tubes *partially empty*—a condition essential to the development of capillary force. Under these circumstances capillary attraction would draw up warm water from beneath, which, undergoing congelation, would, in like manner, elevate the column of ice still higher; and thus the process would go on as long as the cold continued to operate on unobstructed capillaries, supplied with sufficient water from below. It will be remarked that this explanation makes the whole process of protrusion to take place in a stratum of earth of almost inappreciable thickness. It also presumes that the protruding force act[s] *paroxysmally*" (*Proc. Am. Assn. Adv. Sci.*, *op. cit.*, 30–31). He subsequently remarks (NATURE, *op. cit.*): ". . . In relation to the explanation of the phenomena, I have nothing to add to that given" above, "except in relation to *two points*, viz.: (1) that I did not sufficiently *emphasise* the importance of the fact that the water contained in the *capillary* tubes in the upper stratum of earth is cooled many degrees below the freezing temperature; and (2) that consequently the congelation would necessarily take place *paroxysmally*."

It may be pointed out also that the great majority of the correspondents, both recent and earlier, base their explanations upon isolated observations of phenomena rare in their localities. In reality the extrusion of filamentoid ice-crystals is even more common in certain localities than is indicated by Le Conte's papers and Broun's letter. Thus, in the cultivated fields of the Mississippi valley, during a cloudy day following an autumnal rain, with an air temperature just below freezing-point, the writer has seen a thin layer of soil elevated from one to three inches over fully four-fifths of the area visible from the road throughout a day's journey. Greater length is sometimes attained by the crystals. Within a week the writer has observed, along the roadsides just beyond the limits of Washington, many irregular patches and belts of straight or slightly curved filamentoid crystals, four, six, and even eight inches in height. They were sometimes highest where they supported the greatest weight of earth, leaves, twigs, or pebbles upon their summits. In one case a worn quartzite pebble 1 × 1½ × 2¼ inches was hoisted on a slender tuft of icy needles six or seven inches long, fully two inches above the smaller neighbouring pebbles and the film of soil in which it had been imbedded.

While Le Conte's theory of the formation of the filamentoid crystals extruded from moist earth or wet vegetal stems is acceptable in a general way, repeated observation upon crystals apparently in process of development has convinced the writer that their growth is not paroxysmal. The effect of capillarity

in the moist substance is to keep the bases of the icy filaments, or the lower side of the stratum formed by their agglutination, wet; and congelation of this film appears to be continuous.

W. J. McGee

U.S. Geological Survey, Washington, D.C., U.S.A., February 1

Four-Dimensional Space

Possibly the question, What is the fourth dimension? may admit of an indefinite number of answers. I prefer, therefore, in proposing to consider Time as a fourth dimension of our existence, to speak of it as *a* fourth dimension rather than *the* fourth dimension. Since this fourth dimension cannot be introduced into space, as commonly understood, we require a new kind of space for its existence, which we may call time-space. There is then no difficulty in conceiving the analogues in this new kind of space, of the things in ordinary space which are known as lines, areas, and solids. A straight line, by moving in any direction not in its own length, generates an area; if this area moves in any direction not in its own plane it generates a solid; but if this solid moves in any direction, it still generates a solid, and nothing more. The reason of this is that we have not supposed it to move in the fourth dimension. If the straight line moves in its own direction, it describes only a straight line; if the area moves in its own plane, it describes only an area; in each case, motion in the dimensions in which the thing exists, gives us only a thing of the same dimensions; and, in order to get a thing of higher dimensions, we must have motion in a new dimension. But, as the idea of motion is only applicable in space of three dimensions, we must replace it by another which is applicable in our fourth dimension of time. Such an idea is that of successive existence. We must, therefore, conceive that there is a new three-dimensional space for each successive instant of time; and, by picturing to ourselves the aggregate formed by the successive positions in time-space of a given solid during a given time, we shall get the idea of a four-dimensional solid, which may be called a sur-solid. It will assist us to get a clearer idea, if we consider a solid which is in a constant state of change, both of magnitude and position; and an example of a solid which satisfies this condition sufficiently well, is afforded by the body of each of us. Let any man picture to himself the aggregate of his own bodily forms from birth to the present time, and he will have a clear idea of a sur-solid in time-space.

Let us now consider the sur-solid formed by the movement, or rather, the successive existence, of a cube in time-space. We are to conceive of the cube, and the whole of the three-dimensional space in which it is situated, as floating away in time-space for a given time; the cube will then have an initial and a final position, and these will be the end boundaries of the sur-solid. It will therefore have sixteen points, namely, the eight points belonging to the initial cube, and the eight belonging to the final cube. The successive positions (in time-space) of each of the eight points of the cube, will form what may be called a time-line; and adding to these the twenty-four edges of the initial and final cubes, we see that the sur-solid has thirty-two lines. The successive positions (in time-space) of each of the twelve edges of the cube, will form what may be called a time area; and, adding these to the twelve faces of the initial and final cubes, we see that the sur-solid has twenty-four areas. Lastly, the successive positions (in time-space) of each of the six faces of the cube, will form what may be called a time-solid; and, adding these to the initial and final cubes, we see that the sur-solid is bounded by eight solids. These results agree with the statements in your article. But it is not permissible to speak of the sur-solid as resting in "space," we must rather say that the section of it by any time is a cube resting (or moving) in "space."

S.

March 16

The Action of Very Minute Particles on Light

The action upon transmitted light of very minute particles suspended in a transparent medium is very well known, thanks to the investigations of Brücke, Tyndall, and others, up to a certain point. That is to say, that white light, passing through varying depths of a medium with such particles more or less thickly interspersed, is known to emerge coloured yellow, orange, or red, according to the extent of the action in question. Wishing to illustrate this phenomenon experimentally, I employed a very dilute solution of sodium thiosulphate (hyposulphite), which was acidified with hydrochloric or sulphuric acid, and then allowed to stand, observing from time to time the appearances when examined by transmitted light. The solution mentioned is admirably adapted for the purpose, inasmuch as the precipitation of the sulphur proceeds gradually; and, according to the greater or less dilution at starting, the completion of the reaction can be spread over a long period of time, in some of my experiments occupying more than forty-eight hours. For a while no turbidity whatever is visible; then a faint opalescence makes its appearance, and these exceedingly minute particles grow gradually in size, remaining, however, quite uniformly suspended for a considerable period, until a dimension is reached which causes them to settle out of the liquid. In this way I observed with unfailing regularity, and in unvarying order, though with various degrees of rapidity, an extension of the series of colours, which, so far as I am aware, had not previously been noticed, or at any rate published. From orange, the tint passed successively through rose red, purplish rose, to a full purple; then by insensible gradations to a fine violet, blue, green, greenish yellow, neutral tint, &c.

The solution was contained in spherical or pear-shaped flasks, or in cells with flat and parallel sides. A solution which was strong enough to give well-marked yellow, orange, and red tints, was not well adapted for the subsequent stages, as it soon became white and opaque, so that the later colours were almost entirely masked. A half litre flask filled with a solution so dilute, that ten minutes or more elapsed after acidifying before opalescence was first visible, gave very feeble yellow and orange; the rose and rose purple, though decidedly weak, reminded me in tint of the colours seen towards the upper margin of the recent sky-glows; but when the full purple, violet, and blue were reached, the colours were very strong and well marked. A gas or candle-flame, viewed through the solution, which was violet by transmitted daylight, appeared emerald green. After passing the blue stage, the colours through green and yellow were much weaker, until, as before mentioned, a neutral tint was reached. Beyond this, with such a dilution, nothing further could be satisfactorily observed; but by taking a much more capacious flask, and using a solution only one-half or one-third the former strength, faint orange and pink were again observed *after* passing the neutral point. And with these more dilute solutions, very strongly marked secondary effects were noticed after once passing the "blue stage." A distorted image of a window was formed in the flask, and while the bright portions appeared greenish, those parts where the dark bars of the framework fell, appeared of a fine crimson colour; after the neutral point had been passed, and the bright parts appeared pink, the dark portion of the image appeared a brilliant emerald green. In either of these stages a part of the solution transformed to a tall, but narrow glass cylinder, had not sufficient depth to show any perceptible colour when viewed by transmitted light, but placed on a dark background below a window, showed a crimson or green glow respectively when viewed at a certain angle, and a complementary glow when seen at a different angle (by raising or lowering the level of the eye, the cylinder remaining stationary).

With the solution in any given stage of development, the effect of increasing the depth of the column through which the light passed was to increase the saturation of the colour to a large extent, and to alter its tint (apparently in the direction of the less refrangible end of the spectrum) to a much smaller degree. That the colour observed at any given stage was owing mainly to the size of the individual particles rather than to their greater or less proximity, was shown by the fact that, on pouring away half or two-thirds of the contents of the vessel, and filling with water, the colour, although much thinner, was nearly of the same tint.

I am not able to give the proportion by weight of the salt in the solutions experimented with; but I think about one gramme or less to the litre will be found to give good results. One or two trials, however, would soon indicate the appropriate strength.

The character of the colours and the whole nature of the phenomena led me to infer that they were in all probability caused by the *interference* of light; but as I could not see my way to a *rationale* of the mode of action, I deferred publication in the hope that by further investigation their exact nature and true cause might be more clearly worked out. The description in last week's Nature (p. 439) of Prof. Kiessling's ingenious

"cloud-glow apparatus," by which somewhat similar results have been obtained with steam and sal-ammoniac fumes, induces me to publish my own observations, in the hope that some more competent physicist and mathematician may furnish a satisfactory theoretical elucidation. Lord Rayleigh, I find, has carefully examined the properties of the light *reflected* from an acidified solution of thiosulphate; but its action upon transmitted light appears to have escaped his attention. While Prof. Kiessling's method affords an independent confirmation of the phenomena in question, the thiosulphate solution lends itself much more readily to a study of the successive phases owing to the slow and steady nature of the action and the ease with which, by altering the strength of solution and the depth of the layer interposed, the circumstances can be adapted to the most favourable observation of any portion of the series.

J. Spear Parker

Fall of Autumnal Foliage

That the causes of the fall of autumnal foliage have been for some time removed from the *terra incognita* of the natural history of plants is clear from the fact that the threefold reason is given by Sir J. D. Hooker in so elementary a botanical work as his "Primer of Botany" (Macmillan). The cause assigned by Mr. Henslow in Nature (vol. xxxi. p. 434) will be seen, on reference to the little work mentioned, to be only one of the causes which operate in nature. I may add that I have more than once verified the third reason assigned by Sir J. D. Hooker by experiments on young and old rhododendron leaves, and on leaves of other plants, for my botany classes, and have been surprised at the great difference in the weight of mineral-ash left by equal weights of calcined leaves from the same plant, according as they were culled at the beginning or the end of the season.

Alexander Irving

Wellington College, Wokingham, March 14

[We do not think that either our correspondent or the Rev. G. Henslow has seized the point of Mr. Fraser's letter. This was not an inquiry as to the *modus operandi* by which leaves fall from the plant—a phenomenon which, as Mr. Fraser points out, occurs in India as in Europe. The process is in fact as well understood as anything in the life of the plant. What, however, Mr. Fraser drew attention to was the cause of the *autumn periodicity* of the fall in the higher latitudes as contrasted with what takes place for example in India, where the leaves, as he states, "drop off *gradually* in batches." Neither Mr. Henslow nor Mr. Irving explain why when a traveller from the south reaches Alexandria he finds that "here trees first become deciduous." Leaves fall everywhere, but why north of Alexandria *en masse* in the autumn and south of it in continuous driblets?—Ed.]

Human Hibernation

My letter on the Hibernation of the Siberian mammoth has been followed by two others, extremely interesting, but dealing, I may say exclusively, with the question of human hibernation, and the evidence offered in support of it; this raises a very important consideration, concerning which I ask leave to offer a few remarks:—The "fact," as stated by Mr. Braid, is that credible persons witnessed the burial of a man in a state of sleep or torpor, and that the same man was dug up alive some months afterwards. Why should we not believe this? The answer is not an easy one, nor can it be given in few words, but is in great measure that the same kind of almost unimpeachable testimony is to be had for any number of astounding occurrences, and that if the testimony is to be believed in one case, why should it not be accepted in all others? why are we driven to be so mistrustful? On this I will only say a few words, as your space is so limited. We know that some 5000 or 6000 years ago there existed a people—the Accadians—who, in their cuneiform writings, have left the most complete account of their daily lives and doings. We learn that these men regulated almost every act by the predictions of magicians, astrologers, or one form or another of impostors. We see, therefore, that the world was even then divided into knaves and dupes. Now this has been clearly going on ever since, and probably for indefinite ages before. The knaves having begun as such, have, for the most part, but by no means exclusively, developed into honest, or partially honest, fanatics; the dupes have greatly developed their credulity; and the stage had been reached that an individual with a sane and healthy mind was, if he escaped death, held in such disfavour as to stand a very poor chance in the struggle for existence. The scientific and critical revival of late years has arisen, I believe, partly because life is more secure, and toleration more prevalent, the virtually diseased mental condition is allowed to recover itself. To apply these views to the explanation of the particular case in point above referred to, we must remember that the burial was performed by men, descendants of others wholly unscrupulous, magicians, tricksters, who had probably followed the same calling for ages, and acquired an hereditary skill in such deceptions. Those who have witnessed, as I have done, their marvellous feats—for instance, of the native Indian jugglers—cannot doubt but that the case described was at all events within their power.

Messrs. Maskelyne and Cook similarly can bewilder and defeat the closest "scientific" examination; and is it not obvious but that even here, in the centre of the civilised modern world, the most clumsy impostors are daily bewildering and befooling people who believe themselves to be the possessors of highly cultivated and healthy intellects.

C. K. Bushe

Athenæum Club

Bos Primigenius

In Nature, March 12 (p. 451), a specimen of the jaw of this animal is referred to as having been exhibited at a meeting of the Royal Physical Society of Edinburgh, followed by the remark: "It is apparently the only specimen that had been seen in Britain." Its size is given as 18¼ inches in extreme length." I possess a perfect ramus of a jaw of this species, excavated near Ilford, Surrey, a few years ago, which is fully 21 inches in length in a straight line, and 28 inches measured along the outer curve. There are, I am informed, many specimens of the jaws of *Bos primigenius* in the national collection (presented by the late Sir Antonio Brady), from the same district as my specimen.

West Bank, York — Jas. Backhouse

THE BRITISH ASSOCIATION AND LOCAL SOCIETIES

On behalf of the recently-appointed Corresponding Societies Committee of the British Association, the President and Secretaries are now calling the attention of Local Scientific Societies to certain Rules of the Association adopted at the meeting of the General Committee in November last. It will be remembered that during the last few years the subject of the relation of Local Scientific Societies to the British Association has received considerable attention, and that an opinion has been strongly expressed that the Local Scientific Societies and the British Association might, without any considerable sacrifice of independence, usefully cooperate in facilitating the conduct of investigations into local phenomena such as are frequently undertaken by Committees of the Association.

With this purpose in view the Rules, of which we print a copy, have been prepared, and have now been finally adopted by the General Committee of the Association; and under these provisions a Corresponding Societies Committee has been appointed. To these Rules we would ask the earnest attention of the many local societies throughout the kingdom:—

"*Corresponding Societies*

"(1) Any Society is eligible to be placed on the List of Corresponding Societies of the Association which undertakes local scientific investigations, and publishes notices of the results.

"(2) Applications may be made by any Society to be placed on the List of Corresponding Societies. Application must be addressed to the Secretary on or before June 1, preceding the annual meeting, at which it is intended they should be considered, and must be accompanied by specimens of the publications of the results of the local scientific investigations recently undertaken by the Society.

"(3) A Corresponding Societies Committee shall be

annually nominated by the Council and appointed by the General Committee for the purpose of considering these applications, as well as for that of keeping themselves generally informed of the annual work of the Corresponding Societies, and of superintending the preparation of a list of the papers published by them. This Committee shall make an annual report to the General Committee, and shall suggest such additions or changes in the List of Corresponding Societies as they may think desirable.

"(4) Every Corresponding Society shall return each year, on or before June 1, to the Secretary of the Association, a schedule, properly filled up, which will be issued by the Secretary of the Association, and which will contain a request for such particulars with regard to the Society as may be required for the information of the Corresponding Societies Committee.

"(5) There shall be inserted in the Annual Report of the Association a list, in an abbreviated form, of the papers published by the Corresponding Societies during the past twelve months, which contain the results of the local scientific work conducted by them; those papers only being included which refer to subjects coming under the cognisance of one or other of the various sections of the Association.

"(6) A Corresponding Society shall have the right to nominate any one of its members, who is also a member of the Association, as its delegate to the annual meeting of the Association, who shall be for the time a member of the General Committee.

"*Conference of Delegates of Corresponding Societies*

"(7) The Delegates of the various Corresponding Societies shall constitute a Conference, of which the Chairman, Vice Chairmen, and Secretaries shall be annually nominated by the Council, and appointed by the General Committee, and of which the members of the Corresponding Societies Committee shall be *ex officio* members.

"The Conference of Delegates shall be summoned by the Secretaries to hold one or more meetings during each annual meeting of the Association, and shall be empowered to invite any member or associate to take part in the meetings.

"The Secretaries of each Section shall be instructed to transmit to the Secretaries of the Conference of Delegates copies of any recommendations forwarded by the Presidents of Sections to the Committee of Recommendations bearing upon matters in which the co-operation of Corresponding Societies is desired; and the Secretaries of the Conference of Delegates shall invite the authors of these recommendations to attend the meetings of the Conference and give verbal explanations of their objects and of the precise way in which they would desire to have them carried into effect.

"It will be the duty of the Delegates to make themselves familiar with the purport of the several recommendations brought before the Conference, in order that they and others who take part in the meetings may be able to bring those recommendations clearly and favourably before their respective Societies. The Conference may also discuss propositions bearing on the promotion of more systematic observation and plans of operation, and of greater uniformity in the mode of publishing results."

UNDERGROUND NOISES HEARD AT CAIMAN-BRAC, CARRIBEAN SEA, ON AUGUST 26, 1883

THE following letter describes certain underground noises heard on the day of the great eruption of Krakatoa, in a little island of the Carribean Sea, very near the antipodes of the Sunda Strait. It is possibly an interesting instance of propagation of sound through the whole diameter of the earth. I shall first translate the letter of my correspondent, then add some explanatory remarks:—

"South of Cuba, in 80° long. W., and 20° lat. N., the three little islands, Great Caïman, Little Caïman, and Caïman-Brac, are inhabited by a population of tortoise fishermen; there are also a life-boat station and Lloyd's agent. These islands are indeed in the path of the great cyclones of the Antilles, and they witness many shipwrecks.

"In the month of September 1883, as I was in the island Utila, near the coast of Honduras, we heard the first news of the great eruptions of Krakatoa, and talking about those tremendous cataclysms, I met Capt. Robert Woodville, who had just received a letter from the Caïmans; he told me what follows:—

"On Sunday, August 26, the inhabitants of Caïman-Brac were astonished by a noise like the rolling of a distant thunderstorm; the sky was fine, and they at first thought it was a skirmish between a Spanish cruiser and some Cuban smugglers. On the south side of the island nothing was to be seen; they ran across the island, and northward all was quiet too; no smoke nor ship was in sight. The cannonade still continued, and going back again they recognised that the noise came from underground. They were much afraid, and expected their island would soon subside in the sea, or be turned into a volcano. By degrees the detonations ceased, and their fears were quieted. But the phenomenon was not forgotten, and was still talked about when the first news of the Krakatoa eruption came. They made the remark that the Caïmans and Sunda Strait are nearly at the antipodes of each other, and the hypothesis of a correlation between the two phenomena was propounded. . . .

"(Signed) EDMUND ROULET"

I will not be too sanguine, and accept without criticism so abnormal a fact of the propagation of underground sounds from Krakatoa to the Caïmans through the whole mass of the globus; but I will try to show the reasons which tell in favour of such a bold hypothesis, and lead me to accept it provisionally. There are, it seems to me, plausible grounds for admitting that the subterranean noises heard at the Caïmans were the repercussion of the explosions of the great Krakatoa eruption:—

(1) These noises heard at the Caïmans did not come from one of the numerous volcanoes of Central America: if a great eruption had been known on the same day, the inhabitants of Caïman-Brac and Utila would have found out for themselves the co-relation between the two phenomena. From the nineteenth catalogue of C. W. C. Fuchs (*Mineral. Mitth. v. Tschermak*, vi. 185, 1884) we know of the following eruptions which happened in the summer of 1883. The Omotepec, an insular volcano in the middle of the lake Nicaragua, was in eruption on June 19, opening a new crater, and giving way to abundant lava streams; in the month of August the lavas were still burning. Cotopaxi (in the State of Ecuador) had at the end of August (the exact time is not given) a short, but very strong eruption, accompanied by violent earthquakes. I cannot, however, believe that a great eruption, with noises audible at a distance of 1100 to 2300 kilometres, would not have been better noted, if it had taken place on the same day as the great eruption of Krakatoa. This last event has been enough talked about over the whole world to call attention to such a coincidence if it had really existed.

(2) As to the explanation of the Caïman noises by an unnoticed submarine eruption in the vicinity, I have only to state that the great Antilles are not a volcanic region: the nearest volcanic regions are the Little Antilles and the west coast of Central America, both which are too far to allow such an interpretation of the noises heard at the Caïmans.

(3) The great eruption of Krakatoa on August 26 and 27, 1883, was accompanied by subterranean noises which were always described as resembling the rolling of cannon or of thunderstorm. The description from the Sunda Islands does not differ from that from Caïman-Brac.

(4) The subterranean sounds of the Krakatoa eruption have had an enormous intensity, and have been detected at a distance never heard of before. As is well known (*vide* NATURE, vol. xxx. p. 10), the explosions were heard over a circle of 30° radius, *i.e.* 3300 kilometres. It is indeed only the quarter of the length of the earth's diameter; if the hypothesis is true, we would have here a considerable extension of the propagation of the sound through the earth.

(5) Caïman-Brac lies very near the antipodes of Krakatoa. The exact position of Krakatoa is 105° 30′ E. long. and 6° S. lat.; Caïman-Brac, 79° 30′ W. long. and 19° 30′ N. lat. The antipodes of Krakatoa is also 4° 30′ more towards east, and 13° 30′ more towards south; it is in the middle of the United States of Colombia, on the Magdalena River, between the towns Antioquia and Tunja.

(6) The time at which the noises have been heard at Caïman-Brac corresponds sufficiently to what we know about the time of the eruption of Krakatoa. From the report of R. D. M. Verbeek (NATURE, vol. xxx. p. 10) the explosions of the volcano have been noticed in the Sunda Islands on August 26 and 27, and especially on the morning of the 27th. The noise reached its maximum at Buitenzorg on the 27th at 6.45 a.m.; at Batavia at 8.30; and at Telok-Betong at 10 o'clock. From the difference of longitude August 27, 8.30 a.m. at Batavia is the same time as August 26, 8.5 p.m. at Caïman-Brac. If we admit that the propagation of the sound through the 12,000 kilometres of the earth's diameter would take about one hour, the maximum detonations must have reached the Caïmans on August 26 at 9 p.m. Unfortunately the letter of Mr. Roulet does not give us the exact time of day at which the sounds were heard at Caïman-Brac; I have asked my correspondent to complete, if possible, his observation on that point.

I do not wait for the reply before publishing the present communication for the following reasons:—I believe it is very important to call attention without further delay to this fact, and to beg of the inhabitants of the coast and the islands of the Carribean Sea to collect all that can be remembered about these events; perhaps they heard also the noises described at the Caïmans, and they can confirm, or complete, or correct the observation given by Capt. Woodville.

In case the correlation between the noises at Caïman-Brac and the Krakatoa eruption would be ascertained, it would be a fact of uncommon interest which would equal and surpass the other astonishing phenomena to which the cataclysm of the Sunda Strait gave rise: the transmission of the atmospheric waves to the barometers of the whole earth, the propagation of the marine waves to the maregraphs of Europe and America, the crepuscular and auroral glows of the autumn of 1883, the solar corona of 1884 (which is still apparent, and can be observed every day in February and March, 1885), the abnormal polarisation of the sky (A. Cornu), &c., &c. F. A. FOREL

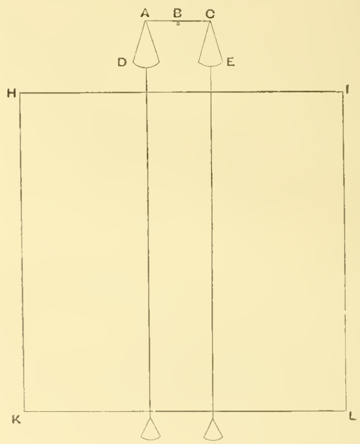
Morges, Switzerland, March 8

REMARKS ON OUR METHOD OF DETERMINING THE MEAN DENSITY OF THE EARTH

IN NATURE for March 5 (p. 403) Prof. Mayer suggests an improvement in our method of determining the mean density of the earth, from which it appears that our plan has not been properly understood. This misunderstanding, no doubt, has arisen from the incomplete description of our method given in the NATURE (Jan. 15, p. 260) report of the *Proceedings* of the Berlin Physical Society, which report was probably the only source of information accessible to Prof. Mayer. We are led therefore to give a short description of our method.

Let H I K L represent a section of a cubical block of lead, about two metres in the edge, and weighing 100,000 kilos. The balance A B C is placed in the middle of the upper horizontal surface. It bears the scale-pans D and E. Under these scale-pans the block is bored vertically through, and two other scale-pans, F and G, are suspended below the block, attached to the balance by means of rods passing through these openings.

A weight in D is brought into equilibrium by weights in G. The weight in D is acted upon by the earth's attraction + that of the block, and that in G by the earth's attraction − that of the block. The weights in G are then greater than that in D by twice the attraction of the block. The weight in D is now removed to F and counter-balanced by weights in E. The weight in E will be less than that in F by twice the attraction of the block. The difference of the two weighings gives therefore four



times the attraction of the block. A correction must be introduced for the variation in the earth's attraction due to the different heights of D, E, and F, G.

In order to obtain as great a deflection of the balance by the method suggested by Prof. Mayer, each of the mercury spheres must exert the same attraction as our lead block. This would require spheres having radii of about one metre. The length of the beam of the balance would be necessarily at least two metres. Besides each mass of mercury would exert some attraction on the weight on the other side, and thus lessen the deviation of the balance.

The method given by Prof. Mayer, except for the suggested employment of mercury, is then no improvement on ours. If we should use mercury, we would construct a cubical vessel to contain it, and use it as we propose to use the lead block. The advantage of using mercury is, however, counterbalanced by the difficulty of obtaining it in such large quantities as would be necessary.

ARTHUR KÖNIG
FRANZ RICHARZ

Berlin, Physical Institute of the University,
March 15

SATURN

IT is to be hoped that Continental observers may have been more favoured than ourselves with opportunities of scrutinising that grand display which has been for some time presented to us by this, the most wonderful of all the solar train. For more than one reason the almost unbroken persistence of that vaporous shroud which has long been investing our unfortunate sky is matter of especial regret. The broad development of that system in all its equally strange and beautiful detail;—its lofty culmination in our midnight heaven;—the probability that many who might look upon it now may never witness its return to a similar position of advantage—all find their place in the account. We can only now look for intelligence from other quarters, and hope that something more cheering may yet be in store for ourselves, before the advancing twilight steals away our opportunities; and that possibly, before these remarks meet the public eye, a change may have supervened to gladden the heart of the British observer.

Few of us, probably, would be likely to express ourselves as an individual once did, who, having for the first time seen Saturn through a good telescope, turned hastily away with a fervent aspiration that he might never see such a sight as that again! But the feeling that broke out in so grotesque a fashion is not altogether unintelligible. Many objects are more imposing in magnitude or brilliancy: none rival it in the impression of surprise. It is absolutely unique. Nothing else resembles it or approaches it in the whole visible creation. But this is not all. Our first impression of astonishment will be succeeded by the demands of a legitimate curiosity, and we shall begin to gaze upon that most charming combination of elegant outline and varied shading, not merely as a subject of admiration, but of close and careful study: we shall naturally inquire how far we understand what we are permitted to see, and how far that great mystery has been penetrated by the modern unrivalled extension of optical power. And here we may feel some disappointment when we are forced to admit that little corresponding advance in knowledge has waited on the increased means of investigation. There was an early dawn of hope and promise after the elder Herschel had shown what telescopes could do. Dawes, Lassell, Bond, De la Rue, Struve, not to mention others, at once overleaped all previous barriers, and showed how full that marvellous whole is, of not less surprising detail. But it is not encouraging to note how little progress, comparatively speaking, has been made of later years. With advantages so incontestably superior, what have we detected, on the whole, more than what passed before the attention of a previous generation? Take, for instance, the beautiful designs of De la Rue in 1852 and 1856; or the elaborate memoir of the observers at Harvard, published in 1857. What material progress have we to boast of? What further light have the same instruments, or others of greater power, thrown on the minute subdivisions of the rings, or the abnormal and inexplicable outlines of the shadow of the globe? On the contrary, with the exception of the radial streaks or notches figured by Trouvelot, the existence of which seems incompatible with the received idea as to the structure and rotation of the rings, how little can be mentioned, traces of which, to say the least, cannot be found even in very early records! The brilliant spot detected by Hall seems to have been in some measure anticipated, notwithstanding the inferiority of their instruments, by Cassini and Fatio nearly 200 years previously. The dusky markings on the ball appear in the rough designs of the elder Herschel, who also noted, for about a week in 1780, a division, possibly not since seen, near the inner edge of one ansa only of the broad ring. The curious striations of the outer ring shown, among others, by the beautiful object-glass at Nice, date back to the $6\frac{1}{4}$-inch reflector of Kater in 1825, if not to an earlier instrument of Short's; while their existence is now unaccountably ignored by the gigantic achromatics of Chicago, Princetown, and Washington; and other details might be specified, described in earlier days, but not corroborated or referred to now. This is certainly not what might have been expected; nor is it easy to assign its cause. Instrumental imperfection cannot be alleged: some minute dark markings might possibly be obliterated in telescopes which give large spurious disks; but this idea is incompatible with the separation of extremely close stars which the modern instruments effect. Irradiation cannot be supposed to affect perceptibly light of so little intensity as that of Saturn. As far as atmosphere is concerned, we in England might claim many an excuse for failure; yet Dawes and De la Rue and others would point to results unsurpassed elsewhere, and with no more efficient instrument than a $9\frac{1}{3}$-inch mirror by With I have repeatedly seen Encke's division, while it is imperceptible with far superior means in the purer American sky. "Personal equation" might be credited with a share in the discrepancies—as, for instance, when on one occasion I missed Enceladus but caught Encke's hair-line at the very time when the reverse was affirmed by the well-trained eye of a friend; but this would be far from covering the whole amount of difference. It remains, therefore, to be seen whether any further advance can be made by sharper, or more widely diffused, or more persistent scrutiny. We wait for further intelligence. We have not heard how far the most remarkable investigations of Bond and his associates at Harvard have been substantiated by the same instrument in the hands of their successors. Something might be looked for at Greenwich from the ready comparison of the workmanship of Merz and Lassell. Few tidings have reached us from the acute research of Schiaparelli; no results from the splendid Roman sky. A greater mass of evidence might be brought to bear upon debateable points, and, in the present state of science, may reasonably be expected.

But even in an improved position as to information we might find a difficulty in interpreting discordant evidence, and deducing from it a consistent conclusion. At present we may incline to the idea that we must take refuge in an actual change of dimensions, or position, or brightness in some of the details. But, even if this would explain more than it will do, we are at a loss as to the possible cause of such changes.

The great difficulty which confronts us is our entire ignorance of the real nature of our object. A certain degree of previous acquaintance with what is before us may in some cases tend to preoccupy the judgment, but in others it assists in clearing the way. We are seldom puzzled in interpreting the aspect of the moon, because we are persuaded of its general solidity and fixity. But what is it that we gaze upon in Saturn? Analogy, often so valuable an assistant, breaks down here. A magnificent globe is set before us, but how little can we guess its constitution! One step would be gained if its density at all resembled our own; but there we are thrown out at once. We simply cannot imagine a state of things so utterly unlike our own experience, or draw any reliable conclusions from what we see. We may safely infer that the surface of the globe is chiefly shrouded in vapour in which currents ascend or descend according to their temperature, and are swept by different times of rotation into longitudinal streaks. And we may further suppose that the atmosphere is of no great comparative depth from the occasional presence of less uniform variations in form and shading, such as would not be compatible with any great difference of velocity between the highest and lowest strata. But as to what may lie beneath, not a conjecture is available; nor do we know that it is ever exposed to the eye. We may assume that the globe is warmer than surrounding space or such alternating currents would not

be generated. And, further, since we are favoured with such a view of the polar regions as we can never obtain on Jupiter, we may conjecture that the internal heat is not great, or it would tend, by equalising the temperature of the whole globe, to remove that difference of tint which has been often remarked between the polar and more temperate zones. But these are but guesses, and as such they must remain.

Then, as to the complex ring. Its constitution may be deduced, within certain limits, from theoretical considerations; but it is beyond the power of observation to confirm it. Especially as to the aspect of the dusky veil, if we accept the varied tints that have been ascribed to it in opposite ansæ, it can hardly be said to correspond with the idea of a thinly scattered stream of separate luminous masses, and is still less capable—some would say incapable—of such an explanation where it is projected upon the ball. The brighter ring gives no indication of its structure, while showing from time to time marked variations in the relative light of its parts; and of the period of its rotation—*pace* Sir W. Herschel—there is no evidence at all. Some observers have thought the great division dusky, rather than black as it shows itself to others, and the whole system of markings is stated to be occasionally unsymmetrical on the opposite sides of the planet—a very perplexing anomaly; for the only conceivable cause—a perturbing influence of the satellites—must be too feeble to have any perceptible effect, even were they not all drawing in different directions.

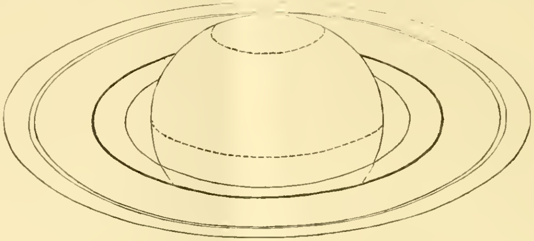


Fig. 1.

This claims to be nothing more than a hasty and incomplete notice of a subject of admitted difficulty. Questions like these might easily be multiplied, especially if we took into account such as arise at the time of the edgewise presentation of the ring, its irregularity of illumination, the probable want of parallelism between the axis of the ring-system and that of the globe, the alleged "square-shouldered" outline, and similar peculiarities. Nor has allusion been made to spectroscopic examination, which is stated to have detected the presence of atmospheric bands and those of aqueous vapour, and may possibly, as in the case of the sun, lead to results beyond the bounds of telescopic research. If what has now been said may serve to stimulate further and closer and more systematic inquiry into this wonderful exhibition of creative power, its purpose will have been attained.

T. W. Webb

P.S.—May I be allowed to add that since the foregoing paper has been in the printer's hands, the kindness

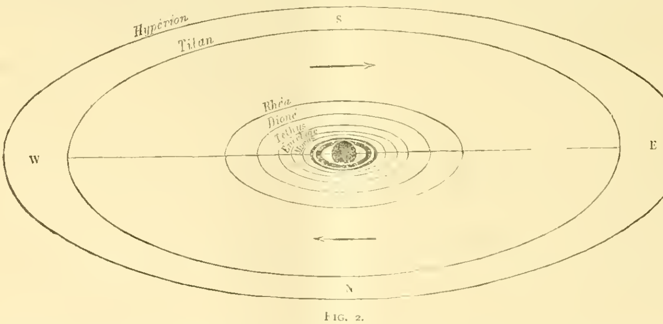


Fig. 2.

of M. Trouvelot has put me in possession of his very important observations of a recent date, proving that, as far as he is personally concerned, there is no foundation for the remarks which I have ventured to make as to our comparative deficiency in progress. His careful and multiplied observations from 1877 to 1884 have led him to the conclusion that many anomalies, not otherwise to be accounted for, must be due to actual variations in the physical structure of the system. It would be a great satisfaction to find that other observatories are likely to prove as fruitful in valuable results as that of Meudon.

I am permitted by the kindness of M. Flammarion to illustrate the present article by two very effective woodcuts, which have appeared in his valuable and interesting periodical, *L'Astronomie*, of which he is now publishing an improved continuation. The first exhibits the existing presentation of the ring system in its fullest possible development; the second, the corresponding projection of the paths of the satellites, in which, however, on account of its great extent, the orbit of the outermost, Japetus, is unavoidably omitted.

T. W. W.

ON PETALODY OF THE OVULES AND OTHER CHANGES IN A DOUBLE-FLOWERED FORM OF "DIANELLA CÆRULEA"

A SPECIMEN, kindly forwarded me by Baron Sir Ferd. von Mueller, of a double-flowered *Dianella cærulea*, has several points of interest. It is an addition to the scanty list of double-flowered plants from the southern hemisphere; it is of interest as having suggested to Robert Brown the establishment of a new species, as was kindly indicated to me by Mr. Baker, while the structural peculiarities it presents are specially worthy of note. With regard to the first point, subsequent experience has shown that the late Dr. Seemann's assertion that there was not "a single double-flowered species known from the southern hemisphere," except *Rubus rosifolius*, no longer holds good, and, indeed, the number of specimens that have from time to time been forwarded to me by Sir Ferdinand von Mueller from various parts of Australia, leads me to believe that such variations are as common in wild Australian plants as in wild European ones, and that, if there be any defect in this particular, it is more apparent than real, and arises partly from insufficient observations, and partly from the relatively smaller number of cultivated plants in Australia. One such instance, that of *Tetratheca ciliata*, presented such features of interest that I made it the subject of a note in your columns, December 7, 1882.

Robert Brown's *Dianella congesta* (*R. Br. Prod.*, 280) is described by Mr. Baker in his systematic summary of the Asparagaceæ (*Journ. Linn. Soc.*, xiv., 1874, p. 576) as having the flowers arranged in dense tufts, in which it differs widely from all the other species of the genus. Mr. Baker expressly says that he had only seen immature flowers. In the "Flora Australiensis," vol. vii., 1878, p. 16, Mr. Bentham alludes to the plant in the following terms:—"*Dianella congesta* . . . appears to me to be a form of *D. cærulea* with dense sessile cymes; the inflorescence, however, in the specimen preserved is scarcely developed, and almost destroyed by insects." The examples sent by Sir Ferdinand von Mueller are, fortunately, in better condition, although, being dried and pressed, they afford little or no opportunity of examining the early stages of development.

Dianella cærulea, as grown in greenhouses in this country, is an elegant perennial plant with grass-like foliage and loose, much-branched cymes of bright blue flowers. Each flower is about half an inch in diameter, and consists of a coloured perianth of six oblong, obtuse segments in two rows; each of the outer segments has five prominent convergent ribs, the inner ones have three only. Within the perianth is a row of six stamens, three of which are placed before the three outer, and three before the three inner perianth-segments, from the base of which they are, indeed, not entirely free. These stamens are remarkable for their thick, club-shaped, fleshy filaments, which support a two-lobed anther opening at the top of each lobe by a terminal pore. The ovary consists of three carpels alternating with the inner row of stamens, and are thus opposite to the sepals, and consolidated into a three-locular ovary with axile placentation, and with numerous ovules in each loculus, the horizontally-disposed ovules being arranged in two longitudinal lines. The ovary ripens into a fleshy ovoid or oblong berry of a lovely blue colour, and containing a relatively small number of seeds as compared to the number of ovules. Indeed, according to the published figures there is much variation in the number of the ripe seeds, abortion of a large proportion being apparently the rule.

So much relating to the usual conformation of the flower is necessary for the comprehension of the changes met with in the malformed specimens. The first thing that strikes attention in them is the substitution of masses of flowers densely crowded into glomerules in place of the light loosely branching panicled cyme met with under normal circumstances. These glomerules look like little "Brussels sprouts," but their constituent parts are somewhat fleshy, and rich cobalt blue in colour. It was this crowded condition of the flowers that doubtless suggested the name "congesta," applied to this form by Brown. On examination of the individual flowers, many changes are observable, and scarcely two flowers present exactly the same characteristics. In most cases a multiplication of the perianth-segments has taken place at the expense of the stamens and carpels, but few or no intermediate forms are met with between petals and stamens, or petals and carpels, neirher are there any indications of staminody of the carpels or the converse. Very frequently the thalamus, or axis of the flower, after having given off several alternating whorls of segments, divides into three or more divisions, each of which, in its turn, gives off successive whorls of densely imbricating blue segments.

The most interesting changes, however, are to be sought in flowers which have not undergone such a serious amount of perturbation as those above-described, and of these a few may be found here and there wedged in among their more full-blown companions. Unfortunately the flowers are so densely packed, and the state of the specimen such, that nothing can be learnt as to the relative position on the inflorescence of these less distorted flowers. The perianth in these cases is normal, but the stamens present some significant changes. The thickened fleshy filament is replaced more or less completely by a slender ribbon-like stalk, not, as in the natural state, continuous with the base of the anther (basifixed), but attached to the back of the anther, a little above its base (dorsi-fixed). This would seem to be an indication that the thickened portion of the filament in the ordinary flower is really an anther-lobe in a state of arrested development.

It will be remembered that Clos and also Goebel are of opinion that the anther is a distinct organ, without direct relation to the lamina of the leaf, and the first-named author considers the filament and its continuation the connective, to be the representative of the median nerve of the petal (Clos: "la feuille florale et le filet staminal"). It would occupy too much space to enter into a discussion on this point: suffice it to add that, in addition to the other changes noted, the anthers in these flowers open by longitudinal slits at the sides, and not by pores. The ovary presented different conditions in different flowers. In almost every case it was preternaturally enlarged, in some instances it was converted from a trilocular to a unilocular condition, owing to the edges of the carpels remaining "valvate," and not inflected, the placentation, of course, in such cases, being parietal, not axile. In other flowers the ovary was represented by three separate, but closed carpels, a retention of juvenile or primordial character, and which, probably, may also be taken as an indication of the condition of the carpels in the progenitors of the Liliaceæ.

But these changes in the carpels are of less interest (owing to the greater frequency of like mutations in other flowers) than are the appearances presented by the placenta and by the ovules, changes unlike anything that has been observed in Monocotyledons, so far as I am aware. These changes in the placenta in the case of the closed unilocular carpels consisted in the outgrowth from the ventral suture of two narrow, parallel, longitudinal plates of a bright blue colour, extending the whole length of the carpels. In flowers in which this petalodic condition of the placenta was present there were no ovules. Are these petal-like processes to be considered as outgrowths from the ventral suture—*i.e.* of foliar origin—or are they to be regarded as springing from the thalamus (axial), and congenitally adherent to the edges of the carpel? Unfortunately there is no means of obtaining a definite reply

to this question. They look as if they were outgrowths from the margins of the carpellary leaf, and I should probably have considered them to be so were it not for certain appearances in the ovules to which I proceed now to allude. In the free carpels, in the flowers I examined, no ovules were apparent, but only the petaloid plates just described ; but in those cases where the carpels were combined into a trilocular ovary, the ovules were present on each side of the ventral suture, not indeed in a perfect condition, but in a more or less abortive state, consisting merely of a funicle and an irregular plate of cellular tissue more or less blue in colour, the only representative of the coats of the ovule, while the nucellus, so far as I could see, was entirely wanting. Still, the general appearance was that of imperfectly developed, pendulous, anatropal ovules.

Petalody, and especially phyllody, of the ovules is not a very uncommon phenomenon among Dicotyledons, and their peculiarities have been discussed at length in numerous classical treatises, to which it is not necessary here to refer. The corresponding changes in the ovules of Monocotyledons must be very much less frequent. There are none recorded in my "Vegetable Teratology," in which I endeavoured to render the bibliographical notices as complete as possible up to the time of publication, and there are none that I have hitherto been able to find in any subsequently issued publication. It is quite certain then that ovular changes must be of extremely rare occurrence in Monocotyledons. Another point remains to be mentioned—the ovules or their abortive representatives were decidedly pendulous from the ventral suture, but in the same carpel it often happened that two flat, tongue-shaped, petaloid processes projected one on each side vertically upwards from the base of the ventral suture, but quite free from it above their point of origin. These may be the representatives of ovules in spite of their different direction, for a different position of the ovules in the same carpel is by no means an uncommon circumstance, though I am not aware that it has ever been observed in *Dianella*. Naturally one is disposed to connect them with the petaloid plates projecting from the placenta above described ; but unfortunately I was unable to find any intermediate condition between the petal-like plates attached to the placenta for its whole length and those which arose from the base of the carpel free throughout their entire length. It is to be hoped that this variety may have been introduced into our conservatories, where, independently of the opportunity for more complete investigation that would thus be afforded, it would be welcomed for the brilliancy of its masses of flowers.

MAXWELL T. MASTERS

MUSICAL SCALES OF VARIOUS NATIONS [1]

AT the Society of Arts yesterday, Sir F. Abel, C.B., F.R.S., Chairman of the Council, in the chair, Mr. Alexander J. Ellis, F.R.S., read a paper on "The Musical Scales of Various Nations," illustrated by playing the scales on his Dichord (a double Monochord, corrected so as to give the true intervals) and five English concertinas, specially tuned by Messrs. Lachenal, which also enabled him to play strains in some of the scales, and by various native instruments lent for the purpose by Rajah Ram Pal Singh, Mr. A. J. Hipkins, and Mons. V. Mahillon. The nations represented were chiefly those of ancient Greece, Arabia, India, Java, China, and Japan, with rapid glances at subordinate places. The relation to his former paper on the History of Musical Pitch was this, that whereas that paper gave the variations in the pitch of the European tuning note, the present endeavoured to discover the system by which different nations tuned. This was obtained when possible by theory, taking as authorities Prof. Helmholtz for ancient Greece ; Prof. J. P. N. Land, of Leyden, for Arabia and Persia, and Rajah Sourindro Mohun Tagore for India. When theory was not possible, results were obtained by measuring with his series of 100 tuning-forks the pitch of the notes produced by instruments of fixed tones (as the wood and metal bar harmonicons in Java and elsewhere), or those produced by native players on other instruments (as by Rajah Ram Pal Singh for India, the musicians of the Chinese Court of the Health Exhibition, and of the Japanese village). In obtaining these pitches Mr. Ellis was materially aided by the delicate ear of Mr. A. J. Hipkins, who most kindly cooperated with him in every way. From the pitches thus obtained, the intervals were expressed in hundredths of an equal Semitone (for brevity called cents) of which 1200 make an Octave, 702 a perfect Fifth, 498 a perfect Fourth, 386 and 316 perfect major and minor Thirds. Then these were plotted down on the movable fingerboards of the Dichord, and the scales were made audible. Occasionally forks were constructed of the pitch observed, and from them concertinas were constructed, and thus the most unusual intervals were reproduced to the ear, and their exact relation to those on a well-tuned piano rendered sensible to the eye. After rapidly exhibiting the ancient and later Greek scales, Mr. Ellis turned to Arabia, for which Prof. Land had furnished the data in his *Gamme Arabe* read before the Oriental Congress at Leyden. This showed first the Pythagorean scale, and then its modification by the lutist Zalzal, 1000 years ago, whereby a fret was introduced between those for E flat, 294 cents, and E, 408 cents (supposing the open string to be C), producing the neutral Third of 355 cents, so that the scale became C 0, D 204, E neutral 355, F 498 cents, followed by the same a Fourth higher, and by a whole tone. This was the system prevalent at the time of the Crusaders, who seem to have brought it to Europe in the shape of the bagpipe, and it is still preserved on good highland bagpipes (as those of Glen and Macdonald) as was proved by taking the scale of one kindly played by Mr. C. Keene, the artist. After the time of the Crusades, Arab theorists, scandalised at giving up the series of Fourths to produce the neutral Thirds and Sixths, carried on the system of Fourths to 17 notes, using 384 and 882 cents for Zalzal's 355 and 853 cents, but preserving his name. So came about the mediæval Arabic system of 17 notes to the Octave, from which 12 scales were constructed, of which Mr. Ellis was able to play 10 on one of his concertinas. But Zalzal's system did not die out, and in 1849 Eli Smith, an American Missionary at Damascus, translated a treatise by Mesháqah, a learned contemporary musician, showing that it led to the division of the Octave into 24 Quarter-tones, with the normal scale of 0, 200, 350, 500, 700, 850, 1000, and 1200 cents, while the player was allowed, in certain cases, to increase or diminish the interval by 50 cents, or a Quarter-tone. Eli Smith gives 95 Arabic airs in this system, of which a few were played on a special concertina. The two important points of Arabic music were the introduction of the neutral Third and Sixth, and the variation of normal notes by a Quarter-tone, both thoroughly inharmonic.

In India the ancient scale was the same as our just major scale, with the exception of the Sixth, which was a comma sharper. Hence it had C 0, D 204, E 386, F 498, G 702, A 906, B 1088, C 1200 cents. But then the major Tones were considered to be divided into 4 degrees, the minor Tones into 3, and the Semitone into 2 degrees, and tones were depressed by 1, 2, or 3, and in one case F, raised by 2 or 3 degrees, and thus the 12 changing notes were produced, answering to our 5 chromatic notes, with 7 notes altered by a degree from them, equivalent to the similar process in the Arabic scale. In modern times the scale was simplified by dividing the distance C to F on the finger-board into 9 equal parts, and from F to *c* (the Octave) into 13 equal parts, and then dividing the 22 degrees among the notes thus: (where the figure before the note indicates the number of

[1] Contributed by the Author.

degrees, and the figures after it the number of cents in the interval from the lowest note, while the terms "very" flat and sharp are those used by Rajah S. M. Tagore, President of the Bengal Academy of Music):—1 C 0, 2 D very flat 49, 3 D flat 99, 4 not used, 5 D 204, 6 E very flat 259, 7 E flat 316, 8 E 374, 9 E sharp 435, 10 F 498, 11 not used, 12 F sharp 589, 13 F very sharp 637, 14 G 685, 15 A very flat 736, 16 A flat 737, 17 not used, 18 A 896, 19 B very flat 952, 20 B flat 1011, 21 B 1070, 22 B sharp 1135, and then followed the Octave of the first degree. Mr. Ellis then showed that 4 scales played to him by Rajah Ram Pal Singh corresponded with some of the 32 scales of 7 notes formed by selections from the above 19 (3 of the 22 degrees not being used). There are also 112 scales of 6 notes, and 160 of 5 notes, or 304 scales in all enumerated by Rajah S. M. Tagore. In addition to this the peculiarities of the 6 modes (*rágas*) and their numerous "wives" or modelets (*ráginís*) had to be taken into consideration.

This Indian system, based on stringed instruments, is, however, quite different from that (if any) of the uncultivated tribes. For instance, a wood harmonicon from Patna gave the scale 0, 187, 356, 526, 673, 856, 985, 1222 cents, where the intervals of the Fourth, Fifth, and Octave were mistuned; but the neutral Third and Sixth, 356 and 856, were introduced.

After dealing with some more instruments of the same kind from Singapore, Burmah, Siam, and West Africa, Mr. Ellis proceeded to the scales which are mainly pentatonic, the most perfect of which are those of Java, which he had acquired from the band at the Aquarium in 1882, checked by the observations of Prof. Land and others on similar instruments in Holland. These scales are of two totally different kinds, called Salendro and Pelog. The ideal of the first seems to be the division of the Octave into five equal parts, giving the scale 0, 240, 480, 720, 960, 1200 cents., so that there is a flat Fourth, sharp Fifth, and almost perfect natural Seventh (960 for 969 cents). By playing pentatonic Scotch airs on a concertina thus tuned, Mr. Ellis showed that the scale gave perfectly recognisable results, and he then played some Javese airs reported by Raffles. In this scale no interval between successive notes was so small as a whole Tone, or so large as a minor Third, but approached a neutral 250 cents, which is constantly accepted as one or the other almost indifferently.

The second or Pelog scales have also five notes, but they are selected from a fund of 7, which (being numbered I. to VII.) have the following intervals from the lowest in cents:—I 0, II 137, III 446, IV 575, V 687, VI 820, VII 1098, I 1200. From these the annexed scales were formed:—

Pelog	0,	446,	575,	687,	1098,	1200 cents.
Dangsoe	0,	137,	687,	820,	1098,	1200 ,,
Bem	0,	137,	575,	687,	1098,	1200 ,,
Barang	0,	137,	575,	687,	820,	1200 ,,
Miring...	0,	446,	575,	820,	1098,	1200 ,,
Menjoera	0,	137,	446,	575,	1098,	1200 ,,

These numbers represent the intervals as determined from the pitches actually observed, and it is very improbable that they properly represent the ideal of the intervals, but they were actually used, and hence satisfied Javese ears. It is noticeable, in contradistinction to the Salendro scales, that the Fourth is sharp and the Fifth flat, that there are five intervals approximating to a Semitone (one being exactly a diatonic and another an equal Semitone), and that two intervals are nearly a minor Third, while the Tone proper does not occur. In the individual scales intervals between adjoining notes occur of over a Fourth, or at least a major Third. These two descriptions of pentatonic scales, therefore, quite refute the usual theories, and show that other feelings than those of successions of Fourths and Fifths must have been at work. Mr. Ellis played short strains (not native) to show the effect of these scales on airs.

The presence of Chinese musicians at the Health Exhibition enabled Mr. Ellis, with the aid of Mr. Hipkins, and the cooperation of the Commissioners of the Chinese Court, to take down the pitches of the notes played by natives on (1) the *Ti-tsu*, or transverse flute; (2) the *So-na*, or oboe; (3) the *Sheng*, or mouth organ; (4) the *Yün-lo*, or set of 10 small gongs on a frame; (5) the *Yang-chin*, or dulcimer; (6) the *Tien-tsu*, or tamboura; (7) the *P'ip'a*, or balloon guitar. These scales were very diverse. Probably by different blowing and half covering the holes, 1 and 2 were much altered and could play together, but the scales noted were incompatible. Nos. 1, 2, 3, 4, 5 had all scales of 7 notes, though it was more usual to leave out two notes and play only 5. On 6 and 7 pentatonic scales only were played to them. Nos. 5 and 6 were tuned in their presence. No. 5 was supposed to follow what is given as the scale in Williams's Middle Kingdom, but must have been badly tuned. The following gives the transcription of the Chinese names followed by the cents in the interval from the lowest note; the notes marked * were omitted when only five notes were used:—*Ho* 0, *sz'* 169, **i* 274, *chang* 491, *ché* 661, *kung* 878, **fan* 996, *liu* 1200, which may possibly represent the scale of B flat major, begun on its second note, thus C 0, D 182, *E flat 294, F 498, G 680, A 884, *B flat 996, C 1200. Also the scale played on No. 6, if begun on its Fifth, seemed to be the same. This is the only instance Mr. Ellis met with where two scales were approximately the same. No. 6 has no frets, and hence any intervals were practicable upon it. None of the instruments used equal temperament.

The principal scales of Japan are pentatonic, but they have a means of sharpening notes on the *Koto* by pressure on the strings, thus producing more notes. The "classical" music came from China. The "popular" seems to be indigenous. In this case, in the *hiradio-shi* tuning of the *Koto* (the principal national instrument), both Mr. Ellis's authorities (Mr. S. Isawa, Director of the Institute of Music at Tokio, Japan, and a Japanese at present studying physics in Europe) agree that the intention is, given the note of the 1st and 5th strings in unison, to tune the 2nd a Fifth below it, and the 3rd a Fourth below it. As to the 4th they disagree. Mr. Isawa thinks it was tuned a major Third below, the other thinks his countrymen do not know a major Third, but only tune the 4th string by "a sort of instinct" as "a sort of" Semitone above the 3rd, in which case the interval between the 3rd and 4th will also be "a sort of" major Third, and the Fourth, from the 3rd to the 5th string, will be approximatively divided into a Semitone and a major Third, which is, singularly enough, the oldest Greek tetrachord of Olympos, possibly tuned by a similar "instinct." Then the Fourth, from the 5th to the 7th string, would be similarly divided by the 6th string. Hence, taking the 1st and 5th strings as E, we have 1 E, 2 A, 3 B, 4 C, 5 E, 6 F, 7 *a*, approximatively. Mr. Buhicrosan, of the "Japanese Village," Knightsbridge, kindly allowed Mr. Hipkins and Mr. Ellis to take the method of tuning *hiradio-shi* from one of his female musicians and her music-master. Writing the number of cents in the intervals between the strings, the following was the result:—

Theory ...	II 204	III 112	IV 386	V 112	VI 386	VII
Female ...	193	164	362	82	399	
Master ...	185	152	346	107	410	

The differences seem to bear out the other's views, and are an instructive lesson in the inaccuracies of most Asiatic tuning. Mr. Isawa identifies the intentional Japanese twelve pitch-notes with the twelve notes of our equally tempered scale, and the other says that if Japanese music is played on a piano no Japanese ear will be offended. Practically, however, the scale is more like

any badly tuned piano, differing probably from performer to performer, and, as shown by the above comparison, often out by a quarter of a Tone.

Mr. Ellis's conclusion was that there is not anything approaching to a single "natural" music scale. That, on the contrary, the systems, where systems can be said to exist, are very diverse, and often very capricious, and are always very imperfectly carried out. This arises probably from harmony proper being unknown, though *ensemble* playing is common. In the latter case unisons are the rule, the effect being produced by diversity of quality of tone; but certain effects are produced by admitting Octaves, and rarely Fourths and Fifths — no more. Also a kind of polyphony may be remarked, some instruments, especially those with tones of very short duration, being allowed to *discant* while the others go on with the air.

On the whole, Mr. Ellis considers his work has only commenced an investigation which will have to be pursued for many years, principally by physicists with a slight knowledge of music, not by European musicians, whose thoughts are biassed by the system of music in which they are accustomed to think.

NOTES

THE Anniversary Meeting of the Chemical Society will be held on Monday, March 30.

THE Mercers' Company have made a contribution of 52*l*. 10*s*. to the fund on behalf of the family of the late Henry Watts, F.R.S.

WE are glad to see from the recent letter of Sir Spencer Robinson, in the *Times*, that the Admiralty are at last taking to experiment to decide the question as to the best form of war-ship. This is as it should be, and we hope the Admiralty will continue their experiments until they have obtained a solid scientific principle to guide them.

OUR readers may be interested in the following remarkable and well-authenticated instance of the effect of atmospheric influences in varying the distance at which lights are visible at night, communicated to us by a correspondent. The paragraph is taken from the *Aberdeen Journal* of March 21. The steamship referred to was on her weekly voyage from London to Aberdeen, being one of a well-known line of passenger steamers trading within these ports. "*Singular Phenomenon.*—Capt. Marchant, of the s.s. *City of Aberdeen*, reports that owing to the peculiar condition of the atmosphere yesterday morning he saw, quite clear and bright, the Girdleness Light (Aberdeen Bay) at 1 a.m., when his vessel was a little to the south of Montrose, a distance of over thirty-six miles, and when two miles north of Stonehaven he could distinctly see the Buchanness Light (about twenty miles north of Aberdeen and three miles south of Peterhead), at a distance of fully thirty-two miles. The lights are laid down on the Admiralty chart as visible at nineteen and seventeen miles respectively."

THE half-yearly general meeting of the Scottish Meteorological Society was held on March 23. The business before the meeting was :—Report from the Council of the Society ; Report of the work of the Scottish Marine Station, by the Scientific Staff of the Station ; Anemometrical observations at Dundee, by David Cunningham, C.E., Harbour Chambers, Dundee ; Diagram to facilitate hygrometric calculations, by David Cunningham, C.E. ; Formation of snow crystals from fog, by R. T. Omond, Superintendent of Ben Nevis Observatory ; Meteorology of Ben Nevis, to February 1885, by Alexander Buchan, Secretary.

A TELEGRAM from Fort William reports that the Rev. John M'Kintosh, Free Church minister, and Mr. Colin Livingstone, of Fort William, made the ascent of Ben Nevis on Monday. The weather was fine, but, owing to the quantity of snow on the higher part of the mountain, footing in some parts was obtained with considerable difficulty. This was particularly the case for about 1200 feet above the Red Burn, and crossing steps had frequently to be cut in the frozen snow. The occupants of the observatory at the top of Ben Nevis were found in excellent health and spirits. The buildings, with the exception of the chimneys and tower, are buried in the snow, access to the rooms being obtained through the tower by means of a ladder. But, once reached, the rooms are very comfortable. The junior assistant was found amusing himself with a kind of raft, which was carried over the snow by means of a sail.

AT a special meeting of the Institution of Mechanical Engineers, held on the 20th inst., was read, amongst other papers, one by Mr. R. Heenan on the Tower spherical engine. As its name betokens, it consists of a system of parts contained within a sphere, so united as to enable them under the action of steam pressure to impart rotatory motion to a shaft. Considered kinematically, the three elementary moving parts of which the engine is composed are : a pair of quarter spheres, having a circular disk of the same diameter as the sphere interposed between them. The straight edges of the spherical sectors are hinged on opposite sides of the disks along diameters at right angles to each other. Each sector rotates upon an axis of its own, upon which it is fixed symmetrically ; these two axes lie in the same plane, meeting in the centre of the disk at an angle of 135°. The two sectors thus correspond with the two bows of an ordinary universal joint, the disks replacing the crosspiece connecting the bows. Throughout each revolution there are consequently two cavities simultaneously in process of opening and two others in process of closing, all four alike changing at the same mean rate of increase and diminution. If, therefore, the disk with its pair of sectors be encased within a hollow sphere of the same diameter, and, if steam be admitted into the two opening cavities, and exhausted from the two that are closing, continuous rotatory motion will be produced, driving the two shafts represented by the axes of the two sectors. When one of the two opening chambers is only just commencing to open, the other is half open ; so that, while the one is making no effort, the other is in the position of best effort. Although the whole of the engine may be said to be contained within the sphere, it is an interesting feature in the system that the capacity of the engine is no other than the full capacity of the sphere itself, inasmuch as four quarters of the sphere are filled and emptied in one revolution. The Tower spherical engines have been used for the electric lighting of trains on the Great Eastern Railway ; they have continued running since October 26, 1884, with perfectly satisfactory results. The engine is coupled directly to a dynamo specially made, the two being together on one bed-plate. The whole is mounted on the top of the locomotive-boiler behind the dome, so that it occupies no space on the foot-plate, and the steam can be taken direct from the dome. The construction of the engine was illustrated by means of twenty-six diagrams.

WE have received the Report of the City and Guilds of London Institute for Technical Education for the past year.

M. ALBERT GAUDRY, Professor of Palæontology in the Museum of Natural History, has reproduced as a pamphlet a note read by him before the Academy of Sciences on the new gallery of Palæontology added to the Paris Natural History Museum. This is a provisional gallery for the large skeleton of fossil animals ; but M. Gaudry has the vision of a far more perfect and elaborate gallery before his eyes. The new gallery,

he says, in concluding his description of its contents, is far from being sufficient. What is needed is a museum where the fossils could be classified, epoch by epoch, and where it would be easy to follow the history of the development of life from the time at which traces of it are perceptible down to the coming of man. "We may hope that one day France, where Cuvier founded the science of fossils, shall have a palæontological museum worthy of her. Meanwhile the new gallery will render a service, for it will give some idea of the majesty of ancient nature."

THE Electrical Exhibition held at the Observatory of Paris was opened by the President of the Republic on the 21st inst. The Ministers of Postal Telegraphy and Public Instruction were present. A Gramme machine was used for rotating the large dome on the roof of the establishment; the rotation of the dome was made visible at a distance by a ray of electric light sent through the aperture. Transmission of force to a distance was shown by setting into operation a printing machine. A series of lectures is being delivered on the several topics relating to electricity in a room fitted up for the purpose. The first is by M. Wolf, on the Application of Electricity to Astronomy, and the last by M. Marié-Davy, on the Use of Electricity in Prognosticating the Weather. All these lectures will be taken down by shorthand writers and published.

THE *Meteorologische Zeitschrift* for February contains a notice by Dr. Eschenhagen on the effect of the Spanish earthquake of Christmas Day last on the magnetic registering apparatus at Wilhelmshaven. During 1883 neither the earthquake of Ischia nor the Krakatoa catastrophe had any influence whatever on the instruments at that place, while an investigation of the curves of the magnetograph during the Andalusian shocks gave the following results. Of the three instruments employed for measuring magnetic variations, only one, that for the vertical intensity, showed any perceptible change at the time of the shock. The curve for horizontal intensity was broken at that point by an unfortunate accident: the declination instrument marked complete rest, but there was a movement of the unifilar suspended magnet such as might be produced by a shock in the direction from south to north. The movement of the needle at the time of the earthquake had not the character of a magnetic disturbance, but was a simple swinging to and fro. The curve showed a gap at this point, for the rapid swinging could not be registered, until the motion became fainter. The first shock to the balance on December 25 was, with tolerable exactitude, 9h. 52m. Wilhelmshaven time, and ceased at 9h. 56m.; new shocks took place at 9h. 59m., 10h., 10h. 2m., and 10h. 5m. Dr. Eschenhagen does not doubt that the balance acted at this time as a kind of seismograph. Accurate observations as to the precise moment of the outbreak of the earthquake at its centre are not forthcoming; but according to the newspapers the first shock was felt at Madrid at 8h. 53m., Madrid time, while the same time is also given for Seville; we may therefore take this to be the time for the Sierra Nevada region, and the shock in Granada, which lay about the centre of the movement, would then be at 9h. 8m. Greenwich time. At Greenwich, however, it was registered at 9h. 15m. in a similar way to that at Wilhelmshaven. It reached the latter place at 9h. 19.4m. Greenwich time. The distance between London and Granada is about 1650 kilometers, but between Wilhelmshaven and Granada 2040 kilometers, and the wave would have taken 7 m. to traverse the former, and 11·4 m. the latter distance. This would give varying degrees of speed in propagation, and if we regard the difference of 390 kilometers as traversed in 4·4 m., we get a third rate of speed which, perhaps, proves that the speed lessens considerably with the distance. It should not be forgotten that Wilhelmshaven is surrounded by marshy ground, which might have retarded the progress of the shock. It appears, too, that the general movement was not propagated in concentric circles.

A WRITER in a recent issue of the *North China Herald* describes a work on "The Mathematicians and Astronomers of China and Foreign Countries," compiled toward the close of the last century by a scholar who afterwards became Viceroy of Canton. It is in ten volumes and forty-six chapters, of which three only are devoted to foreign astronomers and mathematicians. Forty-one of these are mentioned, but a few foreigners are included in the chapters on the natives, for during the 4000 years which the history covers there has always been a leaking-in of knowledge, in spite of the isolation of China; and when foreign mathematicians were to be had, China has made use them. The earliest Chinese astronomers recorded in this history were in the reign of Huang-Ti, and are purely legendary. One invented the cycle of sixty years, another the twelve musical tubes which constitute the basis of weights and measures. These are supposed to have lived in the twenty-seventh century before Christ, but, as they were not heard of until more than 2000 years later, one may assume almost any thing about them except that they lived at the date assigned to them. The first real astronomers whose names remain are the official astronomers of the Emperor Yao. The foundation of scientific astronomy was then laid in the intercalary month and in the use of an instrument for comparing the movements of the stars and the planets with those of the sun and moon. The next scientific triumph mentioned is the measurement of the width of the earth, which is stated to be 2,333,000 *li* 325 feet from east to west, and 2,335,000 *li* 225 feet from north to south. This statement is found in a certain "Shan Hai Ching," a very old but fabulous work. The Chinese take it as a proof that in ancient times latitude and longitude were understood, because it is said that the official measurer calculated with his right hand, and with his left pointed to the north side of a certain hill. An astronomer who lived in the eleventh century before Christ appears to have been in advance of the Greek mathematician, for it is recorded that he explained to his friend, a certain great sage, that the two sides of a right-angled triangle being taken as three and four, the hypotenuse will be five. The statement as given also embraces the squaring of the circle, "the square comes out of the round as earth comes out of heaven." This comes from an ancient work which is said to be the only one stating the principle that a round heaven rests on a flat earth. But the same book states that the earth is round, and that the length of the day and the variation of temperature depend on the latitude. The Emperor Kang Hsi, towards the close of the last century, pointed to the work here referred to as evidence that trigonometry certainly went from China to Western countries in ancient times. During the various dynasties that have ruled in China since our era, the number of astronomers whose labours are recorded have progressively increased, especially after the invention of printing. The forty European astronomers mentioned form a classified list, mainly of ancient Greeks and moderns. Ptolemy, Copernicus, and King Alphonso are placed side by side, and Tycho Brahe is closely followed by Archimedes and Napier. The translators of scientific books from among the Roman Catholic missionaries in China are in close proximity with Newton and Kepler. They won their position in the Chinese estimation amongst the great philosophers by their efforts as translators to teach the Chinese such facts and theories as they knew. The whole work shows that the Chinese honour men of scientific knowledge, and that a number of themselves are always ready to devote themselves with enthusiasm to the study of the mathematical sciences.

THE Royal Academy of Sciences of Belgium has issued a notice with reference to an extraordinary competition for the

year 1887. The Government has proposed, and the Chambers have adopted a law having for its object the preservation of fish and their restoration to the rivers. The main obstacle to this end is the pollution of the waters of small unnavigable streams by solid and liquid matter poured into them by various industries, which render them unfit for the breeding and existence of fish. The Academy, therefore, calls on science to aid the public authorities. One of its members has placed at its disposal the sum of three thousand francs, which it has decided to spend in giving a prize for a thorough study of the following questions, at once biological and chemical:—(1) What are the special substances in our principal industries which, when mingled with the water of small streams, render them incompatible with the existence of fish and unfit for the consumption of man and beast? (2) Investigation and indication of practical measures for purifying water as it leaves manufactories, so as to render it innocuous to fish without interfering with the industry, combining the expedients offered by decanting basins, filtering and chemical agents. (3) Separate experiments on the substances which in each special industry kill fish, and on the degree of resistance which each species of edible fish offers to this destruction. (4) A list of the rivers in Belgium which are actually depopulated by this state of things, with an indication of the special industries in these rivers, and a list of the edible fish which inhabited them before the establishment of the factories. If a memoir is judged satisfactory for the solution of the two first points, a prize of two thousand francs will be given, even though the two latter questions are untouched. Papers should be legibly written, and should be addressed to M. Liagre, Perpetual Secretary, au Palais des Académies, Brussells, before October 1, 1887. Quotations are to be made with great exactness, and authors should therefore mention the edition and page of works cited. A motto must be selected, and the names inclosed in a separate sealed envelope, with the motto superscribed. The papers sent in will remain in the archives of the Academy.

A RECENT issue of the *Peking Gazette* contains a report from the outgoing Viceroy of Fukhien stating that he had handed over the insignia of office to his successor, including *inter alia* the seal, the imperial death warrant, banners and tablets, and the conch-shell best used by the Throne. The latter has a curious use. A conch-shell with a whorl turning to the right is supposed when blown to have the effect of stilling the waves (from the excruciating nature of the sound?), and is hence often bestowed by the Emperor upon high officers whose duties compel them to take voyages by sea. The Viceroy of Fukhien probably possesses one of these shells in virtue of his jurisdiction over Formosa, to which periodical visits of inspection are supposed to be paid.

UNDER the title "A Prophetic Almanac a Hundred Years ago," *Science et Nature* describes, with illustrations, portion of one of a series of almanacs issued between 1789 and 1799, which has recently been presented to the Paris Bureau of Meteorology. The collection was made at the time by Guéneau Montbeillard, the colleague of Buffon, and the author of the section on birds in the latter's natural history. Montbeillard was also a meteorologist, and his observations, made at his chateau at Semur in Côte-d'Or, can be employed to check the prophecies made in the *Almanach fidèle* published annually at Troyes, "par les soins du sieur Maribas, grand astrologue et mathématicien." Selecting the page of the almanac for the month of March, 1785 (precisely a century ago), we find in the last column, in ordinary language, general predictions for the four quarters of the month. For example: "New moon on the 10th, at 10h. 38m. in the evening, in the sign Pisces. The weather will be fine, and the winds very troublesome." Next to this come four columns, filled with cabalistic signs and occupying the middle of the page. The last of these gives for each day the position of the moon in one of the zodiacal signs. The first of the four indicates by a cross or a triangle whether the day is a festival or a working day. In the second column the nature of the weather which may be expected is marked by a succession of signs, the key to which is given in the first page, while the third, by a similar series of signs, indicates the nature of the operations for which the day in question is particularly favourable. Thus Sieur Maribas advises his clients that March 10th, 11th, and 28th, 1785, are favourable for hair-cutting; the 12th, 13th, and 27th for paring the nails; the 2nd, 14th, and 21st for blood-letting; but there was only one day, March 4, on which pills should be taken, while it would be unwise to wean infants on any day but the 18th. For wood-cutting, the 9th, 15th, or 16th should have been selected, and so on. The philosopher's weather predictions for the month appear to have been falsified in almost every instance. He foretold rain for seven days and snow for two; in fact it rained very slightly on three days, none of which were mentioned by him, and did not snow on his days at all. In temperature his luck was as bad, for the day which he foretold would be warm, was the coldest of the whole year. Besides, "the various changes of the air for each day produced by the stars on our horizon," Sieur Maribas promises in his title page, "several pretty sayings suitable for exhilarating and diverting curious and melancholic minds." Among these meteorological *gentillesses* are the following:—Women are cured of laziness by vanity or by love; To know a woman well, it is necessary to contradict her; Nothing grows old so soon as a benefit. The "grand astrologer and mathematician" evidently intended his "pretty sayings" chiefly for those of a melancholic turn of mind.

WE have received the *Proceedings* of the Holmesdale Natural History Club for the years 1881, 1882, and 1883. This club has its home at Reigate, and its papers, though mainly concerned with south and central Surrey, range over a great variety of natural history subjects. Among the principal papers in this number (which, it should be remarked, would be much improved by an index, or classified list of the papers) are:—The potato disease, by Mr. Gill; the hairs of plants as concerned in the supply of water and nourishment, by Dr. Bossey; ornithology in Wray Park, by Mr. Crosfield; the *Sprolegna ferox* (the freshwater fish parasite), by Mr. Boyle; the habits of the stalk-eyed crustacea of the British Islands, by Mr. Lovett; and the marine life of the Reigate district, by Mr. Gilbert. All the excellent work of the Club appears to be done with an expenditure of from 30*l.* to 40*l.* per annum.

WE are asked to state that in the report of Sir William Thomson's Baltimore lectures, p. 296, in line 13 from the top of the page, and in the left hand members of equations (19) and (21), for "ω" and "ω_1" read "ϖ" and "ϖ_1" respectively.

THE additions to the Zoological Society's Gardens during the past week include a Malbrouck Monkey (*Cercopithecus cynosurus*) from South Africa, presented by Mr. W. E. Clift; a Grivet Monkey (*Cercopithecus griseo-viridis*) from South Africa, presented by Mr. W. Ockey; a Pine Marten (*Mustela martes*) from Ireland, presented by Mr. Frank Sharp; a Bar-breasted Finch (*Munia nisoria*) from Java, two St. Helena Seed-Eaters (*Crithagra butyracea*), a Grey-necked Serin Finch (*Serinus canicollis*), a Brown Canary Finch (*Serinus tottus*), two —— Finches (*Serinus* ——) from South Africa, presented by Mr. J. Abrahams; two Pheasants (*Phasianus colchicus*), British, deposited; a Stein-bok (*Nanotragus tragulus* ♀), four Wattled Starlings (*Dilophus carunculatus* ♂ ♂ ♀ ♀), two White-throated Seed-Eaters (*Crithagra albogularis* ♂ ♀), two Striated Colys (*Colius striatus*) from South Africa, two Brazilian Tanagers (*Ramphocœlus brasilius*), two Green-headed Tanagers (*Calliste tricolor*) from Brazil, purchased

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *MARCH* 29 *TO APRIL* 4

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on March 29

Sun rises, 5h. 44m. ; souths, 12h. 4m. 44·7s. ; sets, 18h. 27m. ; decl. on meridian, 3° 34′ N. : Sidereal Time at Sunset, 6h. 56m.

Moon (Full on March 30) rises, 17h. 20m. ; souths, 23h. 32m. ; sets, 5h. 33m.* ; decl. on meridian, 0° 35′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 3	13 0	19 57	10 27 N.
Venus	5 37	11 32	17 28	1 31 S.
Mars	5 32	11 30	17 28	1 10 S.
Jupiter	14 12	21 28	4 44*	13 49 N.
Saturn	8 38	16 43	0 48*	21 51 N.

* Indicates that the setting is that of the following day.

Occultations of Stars by the Moon

March	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to right for inverted image ° °
29	75 Leonis	5½	0 14	1 25	75 284
29	76 Leonis	6	1 36	2 17	43 334
29	79 Leonis	5½	3 57	4 54	112 287
31	B.A.C. 4591	6	21 20	22 26	18 240

Phenomena of Jupiter's Satellites

March	h. m.		March	h. m.	
29	1 32	I. ecl. reap.	31	19 14	III. ecl. disap.
	19 44	I. tr. ing.		22 41	III. ecl. reap.
	22 4	I. tr. egr.	April		
30	20 0	I. ecl. reap.	1	19 11	II. occ. disap.
31	0 6	II. tr. ing.		23 53	II. ecl. reap.
	3 1	II. tr. egr.	2	2 59	IV. tr. ing.
	19 13	III. occ. reap.	4	3 5	I. tr. ing.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

March 30.—Partial eclipse of the Moon. The times of first contact with the penumbra and shadow are 13h. 49m. and 14h. 58m. respectively ; the middle of the eclipse is at 16h. 34m. ; the times of last contact with the shadow and penumbra are 18h. 9m. and 19h. 18m. respectively. The Moon will rise at Greenwich after having left the shadow but whilst still obscured by the penumbra.

GEOGRAPHICAL NOTES

It seems probable that the Geographical Societies of Berlin and Munich will join that of Vienna in sending Dr. Lenz to Africa.

Mr. O'Neill, our Consul at Mozambique, who has done some excellent exploring work in the Lake Nyassa region, has just arrived in this country, and will shortly read a paper before the Royal Geographical Society.

At the meeting of the Geographical Society on Monday, when a paper by Major Holdich was read on the geographical work of the Afghan Frontier Commission, Sir Richard Temple spoke in strong terms of the complete ignorance of geography in this country and the consequent incompetency of the public to judge of the true bearings of such a matter as that now pending between Russia and England. The Society, he remarked, performs a public service in bringing before the public such papers as that of Mr. Holdich, and we hope they will succeed in obtaining for geography the position it ought to have in English education.

We learn from the *Times* Paris Correspondent that the War Ministries of France, Germany, and Italy have recently been examining attentively geographical maps in relief, constructed on a system of which M. de Mendouca, a Portuguese Councillor of State, President of the Banco Lusitano, possesses the patent, and is the promulgator. These relief maps are stated to combine the advantages generally admitted to be possessed by relief maps and the convenience and accuracy of maps on flat surfaces. The Correspondent states that this new method rapidly reprod. ces, l y a c. nical and mechanical process, plane maps with the curves and altitudes in relief, so represented as to correspond absolutely with the elevations established by accurate observations. These maps are drawn on paper, which may be described as thin. They are not, however, put out of shape even by being trodden upon. Yet they may be rolled up and placed in the narrowest case, so that they are very portable and light. They are not injured by water. The Correspondent soaked one of them for forty-eight hours in water, and, on taking it out, all the part which was in relief—that is all the part subjected to chemical processes—remained absolutely intact. The relief, the Correspondent states, is produced on them in such a manner that at a single glance one can take in the whole topography of a district, its defiles and heights, its water-courses, and all the lesser obstacles of the country in which military operations have to be carried on. Of course relief maps are well known and plentiful. The drawback to those which include large areas is that the altitudinal scale has to be greatly exaggerated. Both in Germany and Switzerland beautiful reliefs of limited areas are made, not only in plaster, but also in papier-mâché, the horizontal and altitudinal scales of which are the same. These new maps, however, seem to possess many advantages over either plaster or papier-mâché, and we should like to know how large are the areas which are contained in them. We are also curious to learn the chemical process used, and whether embossing is not to some extent employed.

In the *Mittheilungen* of the Vienna Geographical Society for February (Bd. xxviii. No. 2), Prof. Blumentritt describes the states existing in the Philippine Islands at the time of the Spanish Conquest. These were of two kinds : Mohammedan principalities, which were the larger and more important, the polity of which was based on the feudal system ; and a vast number of small states, consisting of only a few villages each, in which the Government was based on a complicated system of slavery. The latter is described at considerable length, and is exceedingly interesting. Herr Heller completes his paper on the Rilo-Dagh ; while Baron Kaulbars translates from the Russian the recent letters of Col. Prjevalsky from Central Asia. The President, we are glad to observe, was able to announce that the recent appeal of the Council for more members to enable the Society to take a place worthy of the Austrian capital in geographical science has been very successful, 402 new members having joined up to February 24. At the meeting held on that date the Librarian, Dr. Le Monnier, described Mr. Thomson's recent journey into Eastern equatorial Africa ; and Dr. Zehden read a paper on Shamanism in Upper Austria, which will be printed in the next part of the *Transactions.*

The last number of the *China Review* contains a lengthy paper on Formosa by Messrs. Colquhoun and Stewart-Lockhart. It professes to be based on all available sources of information, and on the evidence of those who have resided and travelled in the island. The most interesting section is one on the Dutch in Formosa, which is followed by an account of the Chinese rule. The physical geography, and the cities and communications, a e treated in some detail ; but the portion on the aborigines was written without much reference to "available sources." The precise position of these aborigines is one of the most curious problems in ethnology, and very much more has been written about them than the authors of this paper seem to be aware of. They note a very curious custom among the males. They are deprived of their eye-teeth, which are knocked out when they are quite young. By some it is thought that this improves the wind for hunting, whilst others consider that it increases the beauty of their appearance.

ACCIDENTAL EXPLOSIONS PRODUCED BY NON-EXPLOSIVE LIQUIDS [1]

II.

The disaster on board the *Triumph*, combined with the fact that this xerotine siccative had been issued to H.M.'s ships generally, the authorities and officers of the navy having been in ignorance as to its dangerous nature, re-directed official attention

[1] Address delivered at the Royal Institution of Great Britain, Friday March 13, 1885, by Sir Frederick Abel, C.B., D.C.L., F.R.S., M.R.I. Continued from p. 472.

to the loss of the *Doterel* on April 26, 1881, while at anchor off Sandy Point, by an explosion, or rather by two distinct explosions following each other in very rapid succession, which caused the death of eight officers and 135 men, there being only twelve survivors of the crew. The inquiry by court-martial into the catastrophe had led to the conclusion that the primary cause of the destruction of that vessel was an explosion of gas in the coal-bunkers, caused by disengagement of fire-damp from the coal with which these were in part filled. Its distribution through the air in the bunkers and in air-spaces adjoining the ship's magazine was believed to have taken place to such an extent as to produce a violently explosive mixture, and that this had become accidentally inflamed, causing a destructive explosion, which was followed within half a minute by the much more violent explosion of the ship's magazine, containing four or five tons of powder, to which the flame from the exploding gas-mixture had penetrated.

The circumstances elicited by the inquiry, coupled with the information relating to explosions known to have occurred in coal-laden ships which had been collected by a Royal Commission in 1876 (of which the lecturer was a member), combined to lend a considerable amount of probability to the view adopted by the court-martial in explanation of an accident for which there appeared to be no other reasonable mode of accounting.

The conclusion arrived at led to the appointment of a committee under the presidency of Admiral Luard (of which Prof. Warington Smyth and the lecturer were members) to inquire into the probabilities of coal-gas being evolved, and of an explosive gas-mixture accumulating in consequence in the coal-bunkers of ships of war, and into the possible extent and nature of damage which might be inflicted upon ships of war by explosions due to the ignition of such accumulations. The committee were also instructed, in the event of their finding that H.M.'s ships were liable to exposure to danger from such causes, to consider and devise the means best suited for preventing dangerous accumulations of gas in the coal-bunkers which are distributed over the various parts of the ship in the different classes of vessels composing the Royal Navy.

The committee instituted a very careful inquiry, and a series of experimental investigations, including the firing of explosive gas-mixtures, in large wrought-iron tanks in the first instance, and afterwards in one of the large bunkers, empty of coal, in an old man-of-war, which afforded some comparison with the condition, as regards the relative strength or powers of resistance of the surroundings, and with the position, relatively to the ship's magazine, of the particular bunker in the *Doterel* in which it was thought the explosion might have originated. The results of these experiments could not be said to do more than lend some amount of support to the belief that effects of the nature of those ascribed to the first explosion in the *Doterel* might have been produced by the ignition of a powerfully explosive gas-mixture, contained in the middle- or athwart-ship's bunker of the ship. The committee's experimental investigations for ascertaining the best general method of securing the efficient ventilation of the coal-bunkers in different classes of men-of-war was, however, of considerable advantage in leading to the general adoption of arrangements in H.M.'s ships whereby the possible accumulation in the bunkers of gas which may be liable to be occluded from coal after its introduction into them is effectually prevented, and the occurrence of the kind of accidents guarded against, of which there are several on record, due to the ignition of explosive mixtures which have been produced in coal-bunkers.

Although the inquiry instituted by the court-martial in August, 1881, into the loss of the *Doterel* was apparently very exhaustive, some significant facts connected with the existence of a supply of xerotine siccative in the ship, which appear to have had a direct bearing upon the occurrence of the disaster, only came to light accidentally in January, 1882. A caulker formerly on the *Doterel*, but then employed in the *Indus*, recognised, while some painting was being done in that ship, a peculiar odour (as he called it, "the old smell") which he had noticed in the lower part of the *Doterel* the night before the explosion; on inquiry as to the material which gave rise to it, he learned that it was due to some of the same material, xerotine siccative, that had caused the explosion in the *Triumph*. Upon this being communicated to the authorities, an official inquiry was directed to be held, and it was then elicited that the very offensive smell due to the crude petroleum spirit of which this xerotine siccative mainly consisted, had been observed not only by this man (who in his evidence before the court-martial had not alluded to the circumstance), but also by several others in the *Doterel*, between decks, the night before the explosion; that, on the following day, a search was made for the cause of the odour, and that a jar containing originally about a gallon of the fluid, which was kept in a space at the bottom of the foremast, together with heavy stores of various kinds, was found to have been cracked, the principal portion of its contents having leaked out into the bottom of the ship. The cracked jar was handed up to the lower deck with the siccative still leaking from it, and orders were given to throw it overboard on account of the bad smell which it emitted; this was done within a very few minutes after the jar had been removed, and the first explosion occurred almost directly afterwards. Instructions had been given to clear up the leakage from the jar after the hatch of the mast-hole had been left off a little time, and it appeared that a naked candle had been given to the man who handed the jar up out of the small store-hold described by that name. There appears very little room for doubt that an explosive mixture of the vapour and air had not only been formed in the particular space where the jar was kept, but that it had also extended through the air-spaces at the bottom of the ship towards and underneath the powder-magazine, so that even the air in the latter may have been in an explosive condition, as many hours had elapsed between the time when the smell of the petroleum spirit-vapour was first noticed and when the first explosion occurred.

The special committee which had inquired into the possibility of the occurrence of a violent gas explosion in the coal-bunkers of the *Doterel* was directed to institute experiments with a view of ascertaining whether the vapour evolved by this xerotine siccative would, in the circumstances indicated by the official inquiry, have furnished an explosive gas-mixture possessing sufficient power to have produced the effects resulting from the first explosion on the *Doterel*, and to have exploded the powder-magazine. A preliminary experiment showed that when a small quantity of the liquid was spilled at one extremity of a wooden channel 7 feet long and 2·5 inches by 3 inches in section, the vapour had diffused itself in the space of three minutes throughout the channel to such an extent that, on a light being applied at one end, the flame travelled along very rapidly to the other end, igniting a heap of gunpowder which had been placed there. Some of the liquid was also spilled upon the bottom of a very large sheet-iron tank, and after this had remained closed for about twenty-four hours, being exposed on all sides to the cool air of an autumn night, and therefore not under conditions nearly so favourable to evaporation as those obtaining in the hold of a ship, the application of flame produced an explosion of such violence as to tear open the tank. Experiments were also made with the liquid in an old man-of-war, under conditions somewhat similar to those which existed in the *Doterel*, and destructive effects were obtained of a nature to warrant the conclusion that the first explosion in the *Doterel* might have been due to the ignition of an explosive mixture of the air in the confined space at the bottom of the ship, with spirit vapour furnished by the liquid which had leaked out of the jar.

It is very instructive, as indicating the manner in which volatile liquids of this class may, if their nature be unsuspected, be the causes of grave disasters, to note that, while stringent regulations apply, and are strictly enforced, in our men-of-war in connection with the storage and treatment of explosives and inflammable bodies carried in the ship, the introduction into the service of this highly volatile liquid, and its supply to ships in small quantities, was speedily followed by two most calamitous accidents because the material was only known under the disguise of a name affording no indication of its character. Its dangerous nature had consequently escaped detection by the officials through whose hands it had passed, the makers of the preparation having, in a reprehensible manner which cannot but be stigmatised as criminal, withheld the information which most probably would have, at the outset, acted as a prohibition to the adoption of this material by the Admiralty for use in ships, or which would, at any rate, have led to the adoption of very special precautions in dealing with this material.

Although not initiated, nor attended, by any explosion, the accident which in December, 1875, caused the loss, by fire, of the training-ship *Goliath* off Grays (near Gravesend) and the death of several of the boys by drowning, claims notice as an illustration of the facility with which, by heedlessness, or inattention to obvious precautions, accidents may be brought about in the use as an illuminating agent of mineral oil or petroleum, even where these are of such low volatility, or high "flashing

point," as to entitle them to be considered as safe, under all ordinary conditions, as vegetable or animal oils. The evidence elicited at the coroner's inquest showed that one of the boys of the *Goliath*, whose duty it was, at the time, to trim the lamps used in the ship, to place them in position and remove and extinguish them in the morning, and to whom this work had been but recently allotted, let fall a lamp which, after having lowered the flame, he had carried from its assigned position into the lamp- or trimming-room, and which he could hold no longer on account of its heated state. The heated oil was scattered upon the floor, and was apparently at once inflamed by the burning wick of the lamp; the floor of the room was, it appears, much impregnated with oil which had been let drop from time to time by lads employed upon the work of lamp-trimming; hence the flame attacked the apartment generally with considerable rapidity, and a wind blowing at the time caused the fire to spread through the vessel so very quickly as to compel many of those composing the crew to jump overboard, and to render the rescue of the boys from burning or drowning a difficult matter. The occurrence of this accident was made the occasion, in some of the public papers, to decry petroleum oil as a dangerous illuminating agent, although it was proved that the particular oil used at the time when the fire occurred had so unusually high a flashing-point that the consequent inferiority of its burning quality had been made the subject of complaint. This low volatility of the oil has been occasionally regarded as one very important element of safety in reference to its employment in lamps, but the lecturer will presently have to refer to circumstances which do not substantiate this view. At any rate, however, although the heated oil which was spilled on to the floor from the lamp was in a condition favourable to immediate ignition by the burning wick, it is not at all likely that the fire would have extended almost at once with uncontrollable violence, especially in face of the excellent discipline and arrangements in case of fire which were shown to have existed in the *Goliath*, if the scrupulous cleanliness and care had been enforced which were essential in a room where lamp-filling and trimming were regularly carried out, and where it was necessary to keep some supply of oil for current consumption. Instead of this, the floor, and probably therefore other parts of the room, appear to have been in a condition most favourable to the rapid propagation of the flame; moreover, the evidence as to proper care having been taken to keep the supply of oil required for current use in such a way as to guard against its being accidentally spilled, or to impress the boys employed upon the work with the great importance of care and cleanliness, was by no means satisfactory, and there can be little doubt that this catastrophe has to be classed among the numerous accidents of a readily avertible kind which have contributed to lead the public to form an exaggerated estimate of the dangerous character of petroleum oil as an illuminant.

The employment of liquid hydrocarbons as competitors with animal and vegetable oils in lamps for domestic use is of comparatively recent origin, although petroleum or mineral naphtha in its crude or native conditions was used at a very early date in Persia and in Japan, in lamps of primitive construction, while in Italy it was similarly employed about a century ago.

The application of the most volatile products of coal distillation to illuminating purposes in a crude way appears to have originated, so far as Great Britain is concerned, with the working of a patent taken out by Lord Dundonald in 1781, for the distillation of coal, not with a view to producing gas, but for the production of naphtha, brown or heavy oil, and tar.

In 1820, at about the time when gas-lighting was being established in London, his successors sold coal-naphtha in the metropolis for illuminating purposes; but the first really successful introduction of naphtha as an illuminating agent was made by Mr. Astley shortly afterwards, through the agency of the so-called Founders' blast-lamp, which came into use for workshops and yards in factories, and of the naphtha lamp of Read Holliday, of Huddersfield, with which we are well acquainted to this day, as, although it never became a success for internal illumination of houses, it still continues in extensive use almost in its original form, by itinerant salesmen and showmen.

In the Founders' lamp a current of air, artificially established, was made to impinge upon the flame and thus to greatly assist the combustion of the crude heavy oil used in it.

In the Holliday naphtha lamp the spirit finds its way slowly rom the reservoir through a capillary tube to a small chamber placed at a lower level, which has a number of circumferential perforations, and is in fact at the same time the burner of the lamp and the vapour producer which furnishes the continuous supply of illuminant, the liquid supplied to the chamber being vaporised by the heat of the jets of flame which are fed by its production.

Between 1830 and 1850 the knowledge of the production not only of oils but also of paraffin by the distillation of coal or shale became considerably developed by Reichenbach, Christison, Mitscherlich, Kane, du Boisson, and others, and the practical success attained by the latter was soon eclipsed by that of Mr. James Young, who, after establishing oil distillation at Alfreton from the Derbyshire petroleum, began to distil oils from the Bathgate mineral in 1850, and soon developed this industry to a remarkable extent.

The first lamps for burning liquid hydrocarbon which competed for domestic use, in this country, with the superior kinds of lamps, introduced after 1835, in which animal or vegetable oils were burned (solar lamps and moderator lamps), were the so-called camphine lamps (known as the Vesta and Paragon lamps) in which carefully rectified oil of turpentine was used. They gave a brilliant light, but soon acquired an evil reputation as being dangerous, and liable, upon the least provocation, especially if exposed to slight draughts, to fill the air with adhesive soot-flakes.

After a time Messrs. George Miller and Co., of Glasgow (who held for a time the concession of the products manufactured by Mr. Young) tried with some amount of success to use the lighter products from the boghead mineral in the camphine lamp, but the chief aim of Mr. Young appears to have been to produce the heavier oil suitable for lubricating purposes, the light oil or naphtha meeting with an indifferent demand as a solvent, in competition with coal-tar naphtha, in the manufacture of india-rubber goods. He, however, himself used the mineral oil produced at Alfreton in Argand lamps in the earliest days of his operations; a small sale of the Bathgate oil took place about 1852–53 for use in Argand lamps, and the earliest description of lamp employed in Germany, where the utilisation of mineral oil as a domestic illuminant was first developed, appears to have been of the Argand type.

In 1853 a demand sprang up for the lighter paraffin oils in Germany. For three or four years previously a burning oil was distilled from schist or brown coal at Hamburg by a Frenchman named Noblée, who gave it the name of *photogene*. The existence in Glasgow of a considerable supply of the oils became known to a German agent, and after they had been exported from Glasgow to Hamburg for a considerable time it was found that the chief purchaser was Mr. C. H. Stobwasser, of Berlin, who appears to have originated the really successful employment of mineral oils in lamps for domestic use, and to have been the first to bring out the flat-wick burners for these oils. After a time Messrs. Young discovered the destination of their oil, and, having brought over a number of German lamps, for which a ready sale was found, commenced the lamp manufacture upon a large scale, and rapidly developed the trade in mineral (or paraffin) oil for burning purposes, which attained to great importance some time before the American petroleum oils entered the market. In 1859 a firm in Edinburgh supplied Young's company with nearly a quarter of a million of burners for lamps, and it was not until 1859 that the foundation of the United States' petroleum history was laid by Col. G. L. Drake, who first struck oil (in Pennsylvania) at a depth of 71 feet, obtaining at once a supply of 1000 gallons per day. The lamps first used in America were probably of German make, but it need hardly be said that the lamp manufacture was speedily developed to a gigantic extent in that country. Some of the earliest lamps for burning mineral oil in dwellings which were produced in Germany and in Scotland, possess considerable interest as ingenious devices for promoting the perfect and steady combustion of the oil, and as attempts to dispense with the necessity of the chimney for the production of a steady light. In one of these a small lamp was introduced into the base or stand of the lamp proper, and a tube passed from over this little lamp, through the oil reservoir into the burner, so as to supply the latter with heated air. In another, a small fan or blower, with simple clockwork attached, to keep it in rapid motion, is placed in the stand, and supplies the flame with a rapid current of air. Among other workers at the perfection of mineral oil lamps was the late Dr. Angus Smith, who produced a double-wick lamp some years before the beautiful duplex-lamps were first manufactured by Messrs.

Hinks. Some of the more recent American lamps exhibit decided improvements in the details of construction of the oil reservoirs, the wick-holders and elevators, the arrangement for extinguishing the lamps, &c.

It does not come within the province of this discourse to deal with the marvellous development of the petroleum industry in America, where the region of Western Pennsylvania now furnishes about 70,000 barrels of oil per day, having up to January 1, 1884, yielded a total of 250,000,000 barrels. Nor would it be relevant to enter upon the equally interesting topic of the recent extraordinary progress of the same industry in the Caucasus, which is chiefly due to Messrs. Nobel Brothers, further than to refer to the fact that the Baku petroleum lamp oil, which supplies the entire wants of Russia, and is gradually obtaining a footing in Germany, and even here, appears, notwithstanding its comparatively high specific gravity, to be adapted for use in mineral oil lamps of the ordinary construction. This seems to be partly owing to the comparatively small proportion of lamp oil that is extracted from the crude Baku petroleum, in consequence of which the variety of hydrocarbons composing that product of distillation which is used for illuminating purposes, presents a narrower range than is the case in the ordinary American petroleum oil of commerce. It has also been established by careful observations which Beilstein has instituted, that some American oil which is specifically lighter than the Baku oil is not so readily carried up to the flame as the latter, by the capillary action of the wick. Mr. Boverton Redwood has carried out some instructive experiments, employing different kinds of wick as siphons, and measuring the quantity of different descriptions of oil drawn over in corresponding periods of time by the different wicks. These showed that the Baku kerosine was drawn over with decidedly greater rapidity than samples of American petroleum of ordinary quality, but that, on the other hand, a sample of American kerosine of the highest quality exhibited a corresponding superiority over the Baku oil experimented with. The nature and behaviour of the wick plays a most important part in determining the efficiency and also the safety of a mineral oil or petroleum lamp, as will be presently pointed out.

Ever since paraffin or petroleum oils, which may be included under the general designation of mineral oils, first assumed importance as illuminating agents, accidents connected with their use have continued to claim prominence among those casualties of a domestic character which tend to cast suspicion on the safety of the material dealt with, or of the method of employing it, under the ordinary conditions fulfilled by its careful use.

The employment as an illuminant of the most volatile portions of petroleum which are classed as spirit or naphtha, has been chiefly limited to the wickless Holliday lamp, in which a small continuous supply to a chamber heated by the lamp flame which surrounds it, furnishes the vapour which maintains that flame, and to the small so-called sponge lamps or benzoline lamps, of which the body is filled with fragments of sponge, and which is intended to be charged only with as much spirit as the sponge will hold thoroughly absorbed; the small flame at the top of the wick-tube being fed by the gradual abstraction of the liquid from the soaked sponge, by the wick of sponge or asbestos which fills the tube. An ingenious application of naphtha as an illuminant consists in filling a reservoir with sponge fragments kept soaked with the spirit, the vapour of which descends by its own gravity through a narrow tube at the base of the reservoir, and issues from a fish-tail burner under sufficient pressure to produce a steady flame for some time.

(*To be continued.*)

SOCIETIES AND ACADEMIES

LONDON

Mathematical Society, March 12.—J. W. L. Glaisher, F.R.S., President, in the chair.—Messrs. Philip Magnus and R. Lachlan were elected Members.—Mr. J. J. Walker, F.R.S., made a second communication on a method in the analysis of plane curves.—Mrs. Bryant, D.Sc., read a paper on the geometrical form of perfectly regular cell-structure. "Investigation of the properties of the rhombic dodecahedron supplies the clue to the solution of two interesting questions, which are the essential, because the pure geometrical, constituent of several questions as to actual forms in physical nature, such as the geometrical structure of compact tissues on the one hand, and the geometrical form of the honeycomb cells on the other hand. The first question is as follows:—If space were filled with spheres, and this spaceful of spheres were then crushed together symmetrically till the whole became a solid mass, what shape would each sphere ultimately assume? Since twelve is the number of spheres that can be placed round one sphere, in contact with it and with one another, it is evident that each of these ultimate solids would be dodecahedral in shape. The second question is the counterpart of the first:—If space were filled with a homogeneous solid, in which equally efficient centres of excavation were distributed uniformly, what would be the ultimate form of the cells excavated, it being supposed that when the excavators cease their work the walls of the cells are uniform in thickness? The answer to the first question is manifestly the answer to this second question also." After a geometrical discussion the author says:—"We should expect to find this dodecahedral shape in nature wherever originally spherical cells have been uniformly pressed together in a complete manner. The condition is probably seldom fulfilled, and examples are therefore difficult to find. We may look for their fulfilment, however, in the centre of a mass of soap-bubbles." The paper then considers the case of the honeycomb cells, with the conclusion: "The above explanation tends, however, to show that the bees need not be credited with any economical instinct to account for their work, but only with those simpler instincts, which enable them to carry out a joint work with perfect regularity and exactness, which simpler instincts, while sufficiently remarkable, are fairly within the limits of credibility."—Mrs. Bryant illustrated her remarks with several models of the cube and the rhombic dodecahedron.—Mr. Kempe, F.R.S., and the President (who stated that he had some few years since considered the matter from another point of view) made some interesting remarks in connection with the subject.—Prof. Sylvester, F.R.S., gave an account of a paper on the constant quadratic function of the inverse co-ordinates of $n + 1$ points in space of n dimensions; and Prof. Cayley, F.R.S., and Prof. Hart spoke on the same subject. As the hour was late Mr. Tucker (hon. sec.) merely communicated the titles of papers by Prof. K. Pearson (on the flexure of beams); Rev. T. C. Simmons (two elementary proofs of the contact of the "N.P." circle of a plane triangle with the inscribed and ascribed circles, together with a property of the common tangents); and by himself (two other proofs of the first part of Mr. Simmons's communication).

Linnean Society, March 5.—Sir J. Lubbock, Bart., President, in the chair.—Messrs. Jas. Epps, Jas. Groves and Wm. Ransom were elected Fellows of the Society.—Mr. E. M. Holmes exhibited a number of new species of British algæ, viz. thirteen from the south coast of England, and six obtained from Berwick-on-Tweed and Fifeshire. He also called attention to examples of the leaves of *Eucalyptus Staigeriana*, which are remarkable for their fragrant odour, resembling that of verbena, due to a volatile oil which is stated by Mr. Bailey, the Government botanist at Brisbane, to be likely to form an article of commerce in the future. Mr. Holmes also showed a set of plant labels made from the leaves of the Talifat palm. Mr. W. Brockbank exhibited a specimen of *Leucojum carpathicum*, a variety of *L. vernum*, differing from the type by having the flowers tipped with yellow instead of green. The *L. carpathicum* is said now to be seldom met with in English nurseries.—Mr. C. B. Plowright showed and made remarks on a Ranunculus infected with spores of *Urocystis pompholgodes*.—Mr. E. Wethered exhibited some microscopic sections of the "Better Bed" coal-seam of Yorkshire and of the "Splint" coal from Whitehill Colliery, near Edinburgh. He mentioned that Prof. Huxley had drawn attention to the former as containing in quantity sporangia and spores of plants allied to the recent club mosses. Mr. Wethered averred that these were only found in numbers in the topmost three inches of the coal-bed, but very sparsely in the lower portion of the seam. In the Edinburgh splint coal only four inches of the basal and but a part of the upper layer contained spores. Macrospores and microspores were present in both the coals, and, judging from these, he regarded them as belonging to plants resembling or allied to the recent genera *Selaginella* or *Isoëtes*. Mr. W. Carruthers replied, and dissented from this view.—Dr. F. Day read a paper on the rearing, growth, and breeding of salmon in fresh water in Great Britain. He referred to the statements and opinions of the older authorities, and then dwelt more at length on the more recent experiments of Si James Maitland at Howietoun. In December, 1880, Sir Jame

obtained salmon eggs and milt from fish captured in the Teith, and which ova hatched in March, 1881. In July, 1883, it was seen that some of the young salmon, then two years and four months old, were either in the parr livery or had assumed the dress of silvery smolts, the latter in certain lights showing parr bands. On November 7, 1884, a smolt 1¼ lbs. weight jumped out of the pond, and from it about 100 eggs were expressed, and as they seemed to be ripe they were milted from a Lochleven trout.—On January 23, 1885, eighteen of these eggs hatched; the young were strong and healthy. November 11, 1884, about 12,000 Lochleven trout eggs were milted from one of the foregoing smolts, and they hatched January 28, 1885. December 1, 1884: 1500 eggs were taken from two of the foregoing smolts, and treated by the milt of one of the males. On the 9th, about 4000 eggs from these smolts were fertilised from one of the males, and on the 13th, 2500 smolt eggs were milted from a parr. Dr. Day further stated that pure salmon eggs in the Howietoun Fishery have been hatched, that the young have grown to parr, smolts, and grilse; that these latter have given eggs, and their eggs have been successfully hatched. Although time will yet be necessary before a definite reply can be given as to how these young salmon will thrive, how large they will eventually become in fresh water ponds, and whether from them a land-locked race may be expected—still the following points seem to be established. That male parrs or smolts may afford milt capable to fertilise ova; but, if taken from fish in their second season at thirty-two months of age, they are of insufficient power to produce vigorous fry. That female smolts, or grilse, may give eggs at thirty-two months of age, but those a season older are better adapted for the production of vigorous fry, where, to develope ova, a visit to the sea is not a physiological necessity. That young male salmon are more matured for breeding purposes than are young females of the same season's growth. That female salmonidæ under twenty-four months of age, although they may give ova most, are of little use for breeding purposes, the young, if produced, being generally weak or malformed. That at Howietoun, so far, hybrids between trout and salmon have proved to be sterile. Furthermore, it was stated that the size of eggs of salmonidæ vary with the age and condition of the parent, but as a rule older fish give larger ova than younger mothers. Even among the eggs of individual fish, variations occur in the size of the ova. From larger ova finer and rapidly growing fry are produced, consequently by a judicious selection of breeders, races may be improved, but it is only where segregation is efficiently carried out that such selection is possible.—A paper was afterwards read, Notes on some recently-discovered flowering plants from the interior of New Zealand, by the Rev. W. Colenso. In this the author describes and gives field notes on some eighteen supposed new species.

Institution of Civil Engineers, March 3.—Sir Frederick J. Bramwell, F.R.S., President, in the chair.—The paper read was on the construction of locomotive engines, and some results of their working on the London, Brighton, and South Coast Railway, by William Stroudley, M.Inst.C.E. The author, on his appointment to the London, Brighton, and South Coast Railway, in 1870, had to consider what kind of locomotive engine and rolling stock would best meet the requirements of the service; as, owing to the great increase and complication of the lines and traffic, the original primitive engines and rolling stock were not able to do so. He, therefore, in the same year designed a large goods engine, class "C.," arranging the detail so that they would enable him to construct the several classes illustrated, all the principal parts being interchangeable. Having had long experience with both outside- and inside-cylinder engines, he adopted inside cylinders, but placed the crankpins for the outside rods on the same side of the axle as the inside crank, the outside pin, however, having a shorter stroke; and he thus obtained the advantages of both systems. He adopted the method of putting the coupled wheels in front, instead of at the back as usual, which permitted the use of small trailing wheels, lightly weighted, and a short outside-coupling rod for the fast running engines, and also a much larger boiler than could be obtained when the coupled wheels were at the back. The author adopted a somewhat high centre of gravity, believing that it made the engine travel more easily upon the road, and more safely at high speeds; the slight rolling motion, caused by the irregularities of the road, having a much less disturbing influence than the violent lateral oscillation peculiar to engines with a low centre of gravity. The high centre of gravity also threw the greatest weight upon the outside or guiding wheel when passing around curves; and this relieved the inner wheels, and enabled them to slip readily. The author used six wheels in preference to a bogie for these engines, to avoid complication and unnecessary weight. The engines were very light for their power. Spiral springs were used for the middle axle, and these had a greater range than the end ones for the same weight. The two cylinders of the large engines were cast in one piece, with the valves placed below, giving lightness, closeness of centres, and easy exhaust and steam-passages. The crank-axle was the only disadvantage left in an inside cylinder, inside framed engine, and, when this was of good proportions, it offered but a small objection. Owing, however, to the narrow gauge of the rails in this country, the crank-axle could not be made so strong as it ought to be, or there would be no reason why a crank-axle should break. When the flanges of the driving-wheels were turned down thin, so as to avoid the side-shock given by crossings and check-rails, there only remained the strain of the steam upon the pistons to cause breakage; the action of this was precisely the same as the methods used by the late Sir William Fairbairn in testing to destruction the model tube for the Menai Bridge, by letting a heavy weight rest upon it suddenly at frequent intervals. The deflection, if sufficient, caused a crack at the weakest place, which gradually extended until fracture took place. This was precisely what occurred in the axle; the crack invariably commencing on the side of the axle opposite to that to which the steam was applied. The author, after thirty years' experience, believed that the separate parts of locomotives, including tires, axles, piston-rods, side-rods, bolts, cotters, and carriage and wagon axles, broke from the same cause; they did not break when carefully designed, and made with proper materials and workmanship. As the crank-axle could not be made of the proper strength, it was well to consider how to avoid, as far as possible, risk of accident by its failure. By making the axle-boxes and horn blocks deep and strong, giving large flat suraces against the boss of the wheel and the outside of the crank arm, the driving-wheel was kept in position after the axle was broken, if the fracture occurred in the usual place, namely, through the inside web, near the crankpin, or through the centre part where it joined the inside web. An axle, broken in this manner, would run safely over any part of the road, except at a through-crossing, where the guiding-rail was lost, and the flange was liable to take the wrong side of the next point; this, however, had not happened in the author's experience. The author had always hooped the larger cranks, and had for some time hooped every new crank in the same proportion as adopted on the Great Northern Railway, thus reducing the risk to a minimum. The engines had been arranged that part of the exhaust steam might be turned into the tender or tanks, so that the feed-water might be heated. This was a special advantage in a tank engine, by increasing the total quantity of water; it also kept the water supply of greater purity, and it relieved the boiler of a certain amount of duty in heating the water from the ordinary temperature to that which feed-water required. The feed-pumps had been designed to meet the requirements of pumping hot feed-water. The proportions of the valve-gear gave an admission of 78 per cent. of steam in full gear, which could be reduced to 12 per cent. with excellent results; and as at high speeds the steam was never exhausted, the temperature of the cylinder was maintained, and as much steam was locked up in the cylinders as raised the pressure at the end of the stroke to near that in the steam chest. This made the engine run very smoothly at high speeds, and turned what would otherwise be an extravagant coal-burner into an economical machine. And for the same reason the compounding of fast-passenger or frequent-stopping locomotives was not likely to show much, if any, economy over a well-designed, simple engine. The case was different, however, in heavy goods engines, working with a late cut-off most of the time, and where the conditions approximated closely to those of a land or marine engine with a constant load. The back-pressure observed in the diagrams of high-speed locomotives was not therefore a defect, but an advantage, and the author accordingly used small steam-ports and short travel of slide-valve. These remarks as to back-pressure did not apply to the pressure in the exhaust pipes, where it should be as small as possible, but only to the back-pressure in the cylinder. The latter was greatest at high speeds, when a small volume of steam was passing through the cylinders, and small power was required, and least when

working full power with the smallest expansion. All the passenger engines and many of the goods engines were fitted with the Westinghouse automatic air-brake, as were also the whole of the carriages. This brake gave entire satisfaction and complete control of the trains. The author took considerable pains with the fittings and details when it was first introduced, and arranged the gear for the engines, so that the brake acted upon each wheel independently, allowing the springs freedom to act; or it acted upon the front of all the wheels, as in the tank engines, the brake of which was moved by hand as well as by the air-pressure. The Westinghouse air-pump had been fitted with a plunger at the bottom end of the rod, $1\frac{3}{4}$ inches in diameter, and this pumped water into the boilers of the goods engines when they were in sidings or were delayed by signals. For the express and large goods engines the greatest possible amount of heating-surface had been provided; the fire-box was capacious, with small tubes of considerable length in proportion to their diameter, little or no flame being generated with the coal used, and a very small amount of soot. The fuel which was found cheapest to consume in this locality was smokeless coal from South Wales, mixed with a small quantity of bituminous coal from Derbyshire. The boilers were made of the best Yorkshire iron, with plates having planed edges; holes were drilled after the plates had been bent; the joints were butt-joints, and they were hand-riveted. The construction of the ash-pan and its dampers, perforated plates, water-supply, and the arrangement of fire-bars, brick arch, fire-door, and deflector, was shown. The indicator diagrams, taken by one of the Crosby Steam-Gauge and Valve Company's indicators, at various speeds, and under varying conditions of gradient, afforded a fair idea of the working capabilities of these engines, the economical value of which was best shown by quoting the consumption of fuel for the half-year ending June 30, 1884, when the average of the whole of the engines on this line was 29·74 lbs. per engine mile, including the coal used in raising steam. A great number of careful tests had been made of the amount of coal required to raise steam in the engines from cold-water, and also from the partially heated water when the boiler had not been emptied, and this amounted on an average to about 3 lbs. per mile run. Some doubts had been expressed as to the value of heating feed-water by the exhaust steam. The author, therefore, had a number of tests made with the ordinary heating-apparatus removed, and water fed to the boilers by the feed-pumps, and in one series by a Borland's injector. The amount of power required to work the pumps was inappreciable; and the heated feed-water brought about reduction in the consumption of fuel to the extent of over $2\frac{1}{3}$ lbs. per train-mile. It had also been found that heating the feed-water by direct contact of the steam did not, on this railway, injuriously affect the boiler-plates. With a view to ascertain what was the amount of power required to haul a train from Brighton to London, a complete set of 49 diagrams was taken from the engine "Gladstone," working an express train of twenty-three vehicles; the total weight of train and engine being 335 tons 14 cwt. A section of the line was given, and clearly illustrated the result, giving the H.P. at about every mile, the speed, and the gradient. The temperature of the gases in the smoke-box was taken at frequent intervals; also the degree of vacuum in the fire-box and in the smoke-box, and the quantity of water used out of the tender. To the latter had to be added the water condensed from the exhaust, which, from experiments, the author estimated at 20 per cent. This gave an evaporation of 12·95 lbs. of water per 1 lb. of coal, and 1 lb. of coal would convey 1 ton weight of the train $13\frac{1}{2}$ miles, at an average speed of 43·38 miles per hour, over the Brighton Railway, the rate of consumption being 2·03 lbs. of coal per H.P. per hour.

Chemical Society, March 5.—Dr. W. H. Perkin, F.R.S., President, in the chair.—The following papers were read:—On the conversion of Pelouze's nitrosulphates into hyponitrites and sulphites, by Prof. E. Divers, M.D., and Tamemasa Haga.—On the constitution of some non-saturated oxygenous salts and the reaction of phosphorus oxychloride with sulphites and nitrites, by Prof. E. Divers, M.D.—The illuminating power of hydrocarbons. I. Ethane and propane, by Percy F. Frankland, Ph.D., B.Sc.—On benzoylacetic acid and some of its derivatives, Part III., by Dr. W. H. Perkin, jun.

Anthropological Institute, March 24.—Francis Galton, F.R.S., President, in the chair.—The election of the following gentlemen was announced:—F. D. Mocatta, the Hon. Cecil Duncombe, J. G. Frazer, M.A.—A paper was read by Mr. A. J. Duffield on the inhabitants of New Ireland and its archipelago. The author first dealt with the assumption that the inhabitants of these islands are the descendants of remote but superior races, that they retain inherited powers which have become weak by lack of use, and that these moral and intellectual powers can be easily restored. The food of the natives is chiefly vegetable, but they now and then eat the flesh of the small native swine—the opossum—and poultry, which is abundant. The climate is humid and unhealthy; the people poor in flesh, small in size, and light in weight. Their usual colour is a dark brown, but they are a mixed race; the hair is crisp and glossy. The tattooing and cuttings on the flesh are confined to the women and the headmen. The men go absolutely nude, but the women wear "aprons" of grass before and behind, suspended from cinctures made of beads strung on well-made thread; they bleach their hair and paint their bodies with coloured earths. They speak a language which is at once musical and familiar, in which is found a fair sprinkling of Arabic and Spanish words.—Mr. R. Brudenell Carter read a paper on vision-testing; and Mr. C. Roberts read a paper on the same subject.

DUBLIN

Royal Society, January 19.—Section of Physical and Experimental Science.—Prof. C. A. Cameron, M.D., in the chair.—Prof. Emerson Reynolds, M.D., F.R.S., gave a short account of the selenium analogue of the sulphur urea—thiocarbamide—he discovered some years ago. The author, having recently prepared a considerable quantity of cyanamide, and being aware that other chemists had failed to produce selenocarbamide by the molecular change of ammonium selenocyanate, decided to examine the action of hydrogen selenide on cyanamide, as it is well known that thiocarbamide can be easily formed according to the equation $H_2S + \left.\begin{matrix}CN\\H\\H\end{matrix}\right\}N = CS''\begin{matrix}\diagup NH_2\\ \diagdown NH_2\end{matrix}$. F.... grams of cyanamide were dissolved in 50 ccs. of anhydrous ether and a slow current of hydrogen selenide was passed through the solution under a pressure of about 60 mms. of mercury. The gas was slowly absorbed, and at first some selenium separated from the liquid, but on continuing the treatment beautiful colourless crystals separated on the sides of the vessel. The crystals were drained from the etheral liquid, and when exposed to the air were found to be easily reddened by the action of light; they were dissolved in a small quantity of hot water, the solution filtered, and then cooled, when beautiful silky crystals separated which very closely resembled thiocarbamide in appearance and mode of crystallisation. The purified compound proved to be $CSe(NH_2)_2$. The author learned, however, from the January number of the *Journal* of the Chemical Society of London that M. A. Verneuil had just published an account of the same body in the *Bulletin* of the Paris Society. Dr. Emerson Reynolds, therefore, did not continue his investigation, as he believed M. Verneuil to be fully entitled to priority, but contented himself with the exhibition to the society of the specimen of selenocarbamide produced in the Dublin University Laboratory.—On a model illustrating some properties of the ether, by Prof. G. F. FitzGerald, M.A., F.R.S. The model consisted of a series of wheels arranged at equal distances along parallel rows on axes fixed perpendicularly into a board. The wheels were connected together by indiarubber bands, each wheel being so connected with its four neighbours. Under these circumstances it was shown that if any wheel were turned all the wheels turned simultaneously, and that, except for friction on the axes, &c., they would all turn equally. It was explained that the model only exhibited properties of the ether itself and did not exhibit the connections of matter with ether. A region within which the bands did not slip represented a non-conducting region, and differences of elasticity of the bands represented differences of specific inductive capacity, slipping of the bands represented a conducting region, and complete absence of bands represented a perfectly conducting region. When bands were removed from a certain region and all around it a line of bands left, and all around outside this again a conducting region, then if a conducting line connected these regions the wheels along this line might be turned in opposite directions, and when this is done all the non-conducting region is thrown into a state of stress by all the wheels not rotating equal amounts, in which the bands are tight on one side of a pair of wheels and loose on the opposite side. It was explained that this exhibited the

polarisation of the medium between two oppositely charged conductors, the direction of polarisation being at right angles to these bands—*i.e.*, in the line joining the conductors—the medium in this state representing a charged Leyden jar, the two opposite electrifications being represented by the tight and loose bands, one conductor being bounded entirely by tight bands and and the other by loose ones, and the electric displacement of Maxwell being represented by the difference between the two sides of a band. If the bands along any line between the two conductors slipped, all the energy of the medium was spent along this line in friction, and this represented a discharge along the line. This energy was conveyed into the line of discharge by its side and not along its length in accordance with what Prof. Poynting has recently shown to be the case in all electric currents. If the resistance along the line of discharge were sufficiently small the momentum of the wheels would carry them beyond their position of equilibrium and the well-known phenomenon of an alternating discharge would be represented. This led to the observation that the magnetic displacement was represented by the angular velocity of rotation of the wheels and the self-induction by their momentum. It was remarked that the mechanical attraction between the two conductors was not represented, but it was explained that as this depends on the connection of matter with ether it would require more complicated mechanism. It was, however, pointed out that by supposing the wheels slightly distorted by the stress, and by supposing a thread wound around them and each end connected with the material of a conductor, a force would be produced drawing the conductors together owing to the circumference of a distorted wheel being longer than of an undistorted one. This force would be proportional to the square of the distortion, a necessary condition not satisfied by ordinary stresses, and would be, if exerted between two infinite planes, independent of their distance apart, and so must represent a force varying inversely as the square of the distance. Returning to the electric currents, it was shown that by turning the wheels at any point of a conducting circuit the whole region was filled with turning wheels—*i.e.*, with magnetic displacement—and that, if a resistance were introduced at any point of the circuit, the energy would be transferred to that point through the medium and enter by the side of the conductor. If two independent conducting circuits existed near one another it was shown that the phenomena of induced currents were represented. It was explained that the mechanical force was not represented, as it depended upon the connection between matter and ether, but that it might be looked for as in some way depending on the centrifugal force arising from the rotations. The equations representing the energy of the model are of the same form as those of Maxwell representing the energy of the ether when limited by the consideration that the model was only in one plane. It was explained that a tridimensional model whose energy could be represented by the same equations as Maxwell's could not be constructed with indiarubber bands, but might be constructed by means of wheels pumping fluid through pipes. This led to the observation that the propagation of waves by transverse vibrations could be illustrated by the model, and it was explained how a sudden turning of any set of wheels would start a wave-propagation whose direction of propagation was at right angles to the directions of magnetic displacement and of electric displacement, the former represented by the axes of rotation and the latter by the line joining the centres of a tight and loose band. It would be possible theoretically to construct a model illustrating the laws of reflection and refraction of light even at the surfaces of crystalline media, and to reproduce conical refraction. It was explained that by twisting the medium the rotatory polarisation of quartz might be represented, and that probably a mechanism might be introduced by which the rotation of other wheels or of something besides the wheels being altered by the rotation of the wheels, a reaction of the former on the latter would reproduce magnetic rotatory polarisation. It was pointed out that both magnetic rotatory polarisation and dispersion were due to a reaction of the medium during the wave-propagation and not to a change of the medium independent of the wave-propagation. It was explained that it was not to be supposed that the ether was constructed of wheels and indiarubber bands, nor even of wheels pumping fluid in pipes, but it was pointed out that some properties of the ether might be gathered from the model if it be assumed that the qualities of the ether represented by symbols obeying the laws of rotation for instance are really of the nature of rotation. If this be so the ether must be such that any part of it can rotate as often as it likes provided all the neighbouring parts rotate equally and the electrostatic stresses in the ether must be due to the difference of rotation of its parts. If the ether be a perfect liquid it can only have such properties as represent rigidity by being in motion, and it was explained that many electrical phenomena might be illustrated by the polarisation of the vortical motions in a vortex-sponge. Sir Wm. Thomson has pointed out that such a state of polarisation as a single vortex region in the centre of a cylindrical box will not of itself change unless it can spend its energy on the box, which is quite analogous to the fact that the energy of the polarisation of the ether does not disappear unless it can produce heat or mechanical or other forms of energy. It was also pointed out that forces depending on small vortices vanished at small distances from them and that hence the forces depending on their polarisation between two infinite planes would depend on the polarisation and not on the distance between the planes, and so must be of the nature of forces varying inversely as the square of the distance. It was explained that the modes of polarisation of vortices were sufficient to explain both electrical, magnetic, cohesional and chemical forces. It was finally reiterated that the only possible way of giving anything of the nature of rigidity to a perfect liquid was by conferring motion on it and that it seemed likely that any mechanical properties could be conveyed by suitably chosen motions. This was quite in accordance with Sir Wm. Thomson's suggestive address to Section A at Montreal.

Natural Science Section.—V. Ball, M.A., F.R.S., in the chair.—On the physical characters of calcareous and siliceous sponge spicules and other structures, by Prof. W. J. Sollas, M.A., D.Sc., F.R.S.E., F.G.S.—The refractive index of a siliceous sponge spicule, diatom, or other siliceous organic body is determined by immersing it in liquids of different refractive indexes until one is found in which it ceases to be visible under the microscope. The refractive index of this liquid gives that sought for. The siliceous matter of organisms has a refractive index of 1·449, which is that of some kinds of opal or colloidal silica. The refractive indexes of calcareous sponge spicules are found in a similar manner, but as these are biaxial it is necessary to examine them between crossed Nicols; $r_{\epsilon} = 1·485$, $r_{\omega} = 1·659$. These indexes agree with those of calcite. This method of obtaining refractive indexes is applicable to mineral bodies; the glass of the Krakatoa explosion is thus found to have a refractive index of 1·51. Leucite can be thus readily distinguished from analcime and calcite from aragonite. The specific gravity of calcareous spicules (1·62) and that of foraminifera were found by an adaption of the Sonstedt solution method to use with the microscope. The perforate foraminifera have a sp. gr. of 2·65 to 2·67, the imperforate of 2·7 to 2·72, calcite being taken as 2·7. The structure of calcareous spicules was shown by a study of the extinction angles between crossed Nicols, by the development of cleavage planes, and each figures to be purely crystalline. Each spicule is a single calcite individual with its optic axis definitely related to its form. The acerate spicules of calcisponges are distinguished from those of the siliceous sponges by their form, the former often presenting an oval or rhomboidal transverse section. The large spicules of the Pharetrones agree with those of the Calcisponges, with which, therefore, this fossil group must be associated.—On some Trilobites from the Cambro-Silurian rocks of the County Clare by W. H. Baily, F.C.S.—Notes on the coalfields of Leinster and Tipperary by G. H. Kinahan, M.R.I.A.

Cambridge

Philosophical Society, March 2.—Prof. Foster, President, in the chair.—The following communications were made:—On some theorems in tides and long-waves, by the Rev. E. Hill. Elementary considerations were given from which it might be inferred that when a disturbing body produces a semi-diurnal tide in an equatorial canal, the point nearest to the disturbing body will be a point of low tide or high tide according to the depth of the canal. A general explanation was given of the influence of the depth of a canal on the speed of a long wave traversing it. It was shown that the ordinary formula for this speed might be deduced from the ordinary differential equation of motion without integration.—On the electrical resistance of platinum at high temperatures, by Mr. W. N. Shaw.—On an automatic mechanical arrangement for maintaining a constant high potential, by Mr. Threlfall. A water-motor of the Thirlmere type is allowed to settle down to a constant velocity by means of the resistance of a fan which is worked by the motor.

The motor thus governed rotates a shaft on which is a copper disk and two pulleys. The copper disk is placed between the poles of a large electro-magnet: and the second pulley serves to give motion by means of an india-rubber band to a replenisher whose dimensions are determined by the special conditions of the experiment for which the apparatus is to be employed. The regulator, mounted on a box in which is a condenser, consists of a fixed and movable disk, the latter suspended from a spiral spring and carrying a wire across its back turned down at its two ends. The disks are connected with the poles of the condenser, the movable one being put to earth. By means of a Weber suspension arrangement mounted on the top of a guard-hole which protects the spiral spring from currents of air, the attracted disk can be adjusted so that when the difference of potentials arrives at the required value, the wire dips into two mercury cups and so short-circuits a high resistance. By this means a strong current is allowed to flow through the electro-magnet and act as a brake on the copper disk; this causes the velocity of the engine to change and a replenisher to revolve more slowly. When the potentials have fallen sufficiently by leakage or otherwise, the contact at the mercury cups is broken and the motor is enabled to rotate at a higher rate of speed. By this means the potential difference is kept between certain limits depending on the sensibility of the arrangement, and this is increased by having the disks close together and the contact points made of aluminium instead of platinum. Such an apparatus is of use in maintaining condensers, &c., subject to leakage at a constant high potential.

PARIS

Academy of Sciences, March 16.—M. Bouley, President, in the chair.—Reaction of bromine on the chlorides and on hydrochloric acid. A new class of perbromides by M. Berthelot. Fresh experiments made by the author show that the reaction of bromine on the chlorides always liberates heat in the same way as the inverse reaction. In both cases the transformation of the system is always exothermic. Hydrochloric acid and highly concentrated chlorides dissolve bromine in large quantities with liberation of heat, attesting the existence of combinations formed by addition (perbromides of chlorides).—A morphological comparison of Limax (*L. Agrestis, Cimereus* and *Gagates*) with Testacella (*T. haliotidea* and *Maugey*), by M. H. de Lacaze-Duthiers.—On the solubility of the sulphurets of carbon and of chloroform, by MM. G. Chancel and F. Parmentier. The solubility of the sulphuret of carbon in water is shown to diminish according as the temperature is raised. But that of chloroform presents a decreasing solubility from 0° to about 30° C., thenceforth increasing towards its boiling-point.—On the influence of the perturbations in determining the orbits of celestial bodies, by M. E. Vicaire.—A reply to M. Boiteau on the treatment of phylloxera and its winter eggs by washings and sulphur, by M. P. de Lafitte.—Records of the Scientific Mission to Cape Horn (1882–83); Vol. ii. Meteorology, by M. J. Lephay.—Note on the Abelian functions, by M. H. Poincaré.—On the theory of matrices, by M. Ed. Weyr.—On the canonical types of the ternary quadratic forms of differentials whose discriminant is null, by M. G. Königs.—On the electric differences between fluids, and on the part played by the atmosphere in the electrometric measurement of these differences, by MM. E. Bichat and R. Blondlot.—A thermo-chemical study of the fluosilicate of ammoniac: action of the fluoride of silicium on the fluoride of ammonium, and on ammoniac, by M. Ch. Truchot.—Description of a new process for hardening plaster of Paris, by M. Julhe. By the process here described a plaster is produced which may be substituted for wood in floorings, being equally durable and four times cheaper than oak.—Bromuretted substitution of phenolic hydrogen: bromuretted tribromophenol, by M. E. Werner.—On Fromherz's fluid, by M. E. J. Maumené.—On the chemical composition and therapeutic properties of *Artemisia gallica*, Wildenow, by MM. Ed. Heckel and Fr. Schlagdenhauffen.—Physiological action of the hexahydride of β-colladine or isocicutine, by MM. Rochefontaine and Œchsner de Coninck. From experiments made on the frog and guinea-pig the authors find that this substance possesses a physiological action analogous to that of the alkaloid of hemlock (Cicuta). Hence they propose the alternative name of "isocicutine," recalling at once its chief chemical and physiological properties.—Definition, classification, and notation of colours, by M. J. Charpentier. A system of notation and classification is suggested, by means of which a thousand colours may be formulated by the series of natural numbers from 0 to 999, where each cipher takes a precise meaning in virtue of its position. The name of the colour would simply be that of the number symbolising it, and the system might be called the "cubic classification," from the geometrical representation by which it may be best figured.—On the glands and lymphatic vessels entering into the constitution of the organ in birds known as the purse of Labricius, by M. Retterer.—On the physiological effect produced by the action of turning eggs during incubation, by M. Dareste. From experiments made with artificial incubators, the author finds that eggs not turned two or three times a day all perish invariably. The effect of this act on the embryo is explained, and the action of the bird accounted for on strictly physiological grounds.—Ores of the carbonate of zinc: their normal association with dolomitic formations explained, by M. Dieulafait.—On the Miliolideæ of the Chalk formations, by MM. Munier Chalmas and Schlumberger. Idalina, Periloculina, and Lacazina, three new genera from the Upper Chalk of Provence, are described and affiliated to the family of the Miliolideæ.—The channels and lagoons on the east coast of Madagascar, by M. A. Grandidier. These inlets and lacustrine formations are explained by the position of the main water parting, which is usually placed about the centre of Madagascar, but which the author shows is situated much nearer to the east than to the west coast.

VIENNA

Imperial Academy of Sciences, January 22.—On the analysis of andesin of Frifail (Carinthia), by R. Maly.—On the self-purification of natural waters, by F. Emich.—On the action of bile acids on glutin and glutin "peptones," by the same.—On the products obtained by reduction of nitroazoic bodies, and on azonitrilic acids, by J. V. Janovsky.—On the astronomical knowledge of the South Arabian Cabyles, by E. Glaser.—On dehydracetic acid, by L. Haitinger.—Geological researches on the grauwacke formations of the North-East Alps, especially regarding the Semering region, by F. Toula.—On the meteorological observations made at the Austrian arctic station at Jan Mayen during 1882 and 1883, by A. Sobiezky.—On tide observations made in 1882–83 at Jan Mayen, by A. Bobrik.—On the survey of Jan Mayen carried out by the Austrian Arctic Expedition, by the same.

CONTENTS

THURSDAY, APRIL 2, 1885

THE METEOROLOGY OF THE ATLANTIC

Deutsche Seewarte. Segelhandbuch für den Atlantischen Ozean. Mit einem Atlas von 36 Karten. Herausgegeben von der Direktion. Mit zahlreichen in den Text gedruckten Holzschnitten und neun Steindruck-Tafeln. (Hamburg, 1885.)

THE Atlas of the Atlantic which was published by the "Deutsche Seewarte" in 1882, has at length, after a term of three years, been joined by the text, which was intended, in the first instance, to have accompanied it, and of which it was described as an appendix. But though separated in their publication by this wide interval, in spirit and in sense, at least, the two are indissolubly linked together, and either one without the other is but an imperfect and mutilated fragment. Of their excellence, now that they are united, it is unnecessary to speak. When Dr. Köppen, with his able coadjutors, writes, and Dr. Neumayer edits such a work as this physical and meteorological survey of the Atlantic Basin it would be waste of words to say more than that the result of their co-operation must at once take rank as a standard book of reference on this subject. More especially valuable is it in those sections which are descriptive of ascertained facts, and are based to a very great extent on recent, frequently on original observations. The detail of these occupies the largest proportion of the space, leaving but little room for theorising or doubtful matter, and absolutely none for the repetition of those many myths and false statements which have been so often presented to us by successive writers, one blindly copying from another, that we had almost begun—like the poor Hindoo with the mangy cur—to believe in their truth. It is scarcely credible, but is nevertheless a fact, that in this large volume, of nearly 600 closely-printed pages in royal 8vo, there is not a word about ships bound to the West Indies throwing cargoes of horses overboard in the horse-latitudes, which are, however, mentioned as "Rossbreiten"; and the reader will look in vain for the time-honoured allegation that the winter storms on our own coasts are extensions of the West India hurricanes.

The name "Belt of Calm"—"Stillengürtel"—is unfortunately preserved; though the particular "Belt" which has been asserted to exist near the equator is ruthlessly spoken of as "der sogenannte Stillengürtel; and the description of those near the tropics gives no countenance to the pestilential doctrine which the name embodies, but is to this effect:—"Two great whirls occupy the tropical and temperate regions of the Atlantic Ocean; each of these has in the centre a maximum air pressure, around which, in accordance with Buys-Ballot's law, the wind circles, in the direction of the daily motion of the sun in the respective hemisphere. The equatorial sides of these whirls are formed of the trade winds, which thus become more polar on the east side of the ocean, whilst on the west side their direction is due east and so passes to equatorial." "In summer the transition between the west wind of the North Atlantic and the trade takes place, on the coast of Portugal and Morocco, through N.W., N., and N.E., and in the opposite sense on the coast of North America, through S.E., S., and S.W. In winter, on the other hand, the region of high pressure partakes more of the nature of a belt extending from one continent to the other, and the transition is effected in a less regular manner, sometimes with calms, and sometimes with one or more stormy veerings of the wind right round the compass" (pp. 87, 91). All this has, of course, been well known to meteorologists for several years, though it has seldom before been clearly and concisely stated in a practical work of this nature. It seems therefore the greater pity that the name "Belt of Calm" should have been allowed to remain; and it would almost seem that its baneful influence has led the authors to write:—"On the South American coast, from 1°–3° N. latitude, calms and rains prevail almost the whole year through" (p. 65): a statement which does not fully agree either with the wind charts of the atlas, or with the direction in our English "South American Pilot"; according to which the variable winds, calms, and rains last only from the end of April to the beginning of July. The exaggeration is in all probability due to a dim recollection of obsolete maps and a theory that ought to be obsolete, but which from time to time revives in the most unexpected places. To some similar source is perhaps to be assigned the statement that "land and sea breezes are to be found along the whole west coast of Africa from Morocco to the Congo," which is only partially true: on the northern part of this coast, land and sea breezes are, practically speaking, unknown; though from the Senegal southwards they are regular enough.

It is impossible not to regret that statements like this should have been loosely hazarded; for though they are not of much practical importance either way, they tend to raise an unjust suspicion that fanciful theory has been sometimes permitted to dictate the statement of the facts, instead of exact and careful observation. It would have been safer and therefore better to have omitted theorising altogether; for, however tempting it may be, no one knows better than the learned and distinguished editor of this volume that there is as yet scarcely a single point in theoretical meteorology which can be said to be fixed with absolute certainty, or which can be fully and satisfactorily explained. The question of air pressure is one of these. In the theory of meteorology no problem is perhaps so interesting and so important: but in the practical application of rules to which the barometer is a guide, the cause of the variations of the barometer is of no importance whatever. The authors of this book are agreed in the opinion that the pressure of the air at any place depends solely on the weight of the superimposed column of air, and that this weight is dependent on temperature. A great many meteorologists hold this opinion; but many, on the other hand, do not; and, as has been said, there is room to doubt. Temperature alone does not seem to offer any explanation of the barometric maxima near the tropics, or of the barometric minimum near Iceland; still less does it offer any explanation of what Maury first called "The Barometric Anomaly at the foot of the Andes"—the high pressure which has been observed, amidst sweltering heat and extreme humidity, in the valley of the Amazon.

But this is irrelevant to the main purpose of the "Segelhandbuch," and does not at all detract from its

great value as a practical guide. As such, it takes what is, in some respects, a new departure: it rejects the familiar notion that as storms are mere derangements of the system of winds, they deserve, in a systematic study, nothing more than an incidental notice; and it puts prominently forward the idea that, on the contrary, they ought to be studied in very full detail; because, as it argues, the derangements are rather exaggerations than alterations of the system, and are thus capable of serving as a microscope for the student's clearer instruction. It is an idea which has been well and fully worked out; and with a care and industry which supply the reader with an exhaustless mine of illustration and example.

J. K. L.

MUIR'S "PRINCIPLES OF CHEMISTRY"

Principles of Chemistry. By M. M. Pattison Muir, (Cambridge University Press, 1884.)

DURING the last two decades chemistry has made, possibly, its greatest strides, and has unquestionably drawn to itself a greater following of students in this country than in any previous period. One result of that has been a multiplication of text-books such as perhaps no other science can show. This is only as it should be in the case of a living and progressing science like chemistry. But if one musters the style of text-book produced during this period it becomes painfully doubtful whether they as a whole have kept abreast of the mental capacity which should have been, and undoubtedly has, developed during this period.

Chemistry is certainly a practical science, and that in a very full acceptation of the term; but at the same time it has a history as a practical and especially as a theoretical or mental study second to none, and the unsatisfactory part of the majority of the text-books of modern date is that this growth and development, and the invaluable effect of this as a mental training, have been almost completely ignored.

As mathematical men have been heard to say when going through a course of chemical drudgery, "there seems to be nothing but a lot of isolated facts to learn up." And one cannot be surprised at the remark. The text-books may be roughly divided into two sorts—those of a dictionary character and those intended as an introductory or elementary teacher; the former fulfil their intention, which can scarcely be said of the latter, in which the points of principal theoretical interest are "atomicity" and "atomic and molecular combination," and various ways of writing "formulæ."

It is much to be feared that the teaching of the past few years in this country in chemistry has assumed such an intensely "practical" form that philosophical chemistry has been left very much out in the cold. The numerous examinations in which practical work is required has raised up, unfortunately, an army of "test tubers" and crammers whose theoretical knowledge is of the slenderest. Without in the least wishing to underrate the value of practical work, it does certainly appear, looking only at the chemical literature of the past few years, that theoretical chemistry has to a great extent receded from view in favour of practical, and that of a not very thorough kind.

In the present book Mr. Muir has made up for the lacking in our text-books, and has certainly rendered a real service to the English student who aspires to be something more than a mere test-tuber and writer of graphic formulæ.

As the author informs us, the book is intended for students who already have some elementary acquaintance with the science, and is meant to give "a fairly complete account of the present state of knowledge regarding the principles and general laws of chemistry." And in this the author has certainly succeeded; for it may with certainty be said that we have not a more comprehensive work of the kind in the language. For although it does not pretend to the rank of a Kopp, still it quite fills the place in English chemical literature that Lothar Meyer's "Modernen Chemie" does in the German, which latter work, the author tells us, he has made "free use of."

The subject-matter of the book is necessarily extensive, and has been divided into two main parts—Chemical Statics and Chemical Kinetics. The historical method of treatment adopted cannot fail to be appreciated by the real student who aspires to be something more than a mere recipient of dry facts.

The chapter on Atomic and Molecular Systems and on the Application of Physical Methods to Questions of Chemical Statics, as well as that on Affinity, are condensations from all the most recent works on the subjects, and are, as a rule, clear and concise. The references to originals, &c., &c., are numerous, and the mechanical errors throughout the work are surprisingly few.

The book should be very useful to students training for teachers, and who may not have the advantage of reference to original literature on the numerous subjects treated of.

OUR BOOK SHELF

Eine Weltreise. Plaudereien aus einer Zweijährigen Erdumsegelung von Dr. Hans Meyer. (Leipzig: Verlag des Bibliographischen Instituts, 1885.)

THIS handsome volume is something more than the work of a "globe-trotter," even of a very amusing "globe-trotter." Dr. Meyer sailed down the Danube to Constantinople, thence to Athens, Syria (where he visited Smyrna, Beyrout, Damascus, and Jerusalem), Egypt, and by the Red Sea to Bombay. He then travelled through Northern India to Calcutta, and from Madras through Southern India to Ceylon. The journey in the Far East included Singapore, a considerable portion of Java, the Philippines, Hong Kong, Shanghai, and Japan. Thence he reached the United States, through a large part of which he travelled, Mexico, Cuba, and so back to Europe. The journey was more extensive than the usual modern journey around the globe; Java appears to have been thoroughly visited, but the only place in which the work displays any mark of originality is in the Philippines. The scenes and experiences by the way are described with much liveliness, but soon after his arrival in Manila he made a journey into the northern mountainous regions of Luzon, for the purpose of studying the Igorrotos and other tribes having their habitat there. The story of the journey, which occupied about three months, is full of interest, and the ethnology of these tribes is discussed in a special appendix. Prof. Blumentritt, the Austrian scholar, who has devoted many years to the study of the archipelago, especially to the vast Spanish literature of the seventeenth and eighteenth centuries relating to it, comes to the following conclusions on its

ethnography. The authoctonous population of the Philippines, the Negritos, were driven back by two Malay invasions, and are now to be found only in isolated remnants scattered throughout the islands of the archipelago. By the first invasion the Negritos were forced from the coast into the interior, where they remained undisturbed until the second Malay irruption. This drove the first Malay invaders in their turn from the coast, and the descendants of the new comers still occupy the ports and harbours to this day. The Negritos were either destroyed by wars with the first Malays, or completely absorbed by marriage with them, that now no tribes of them are to be found. The Malays of the first invasion came from Borneo, and are found to-day in the mountain districts of Luzon, under various tribal names, such as the Tingianes, Igorrotos, Guinanes, Apayos, Abacas, Calnigas, Gaddanes, &c.; while the second invaders, now known as Tagals, Pampangos, Visayas, Ilocanes, Cagayanes, &c., inhabit the coast regions, where they were found by the Spaniards in the third quarter of the sixteenth century. Naturally the various tribes were unable to prevent being influenced by each other, as well as from without, and to this we must attribute similarities in many respects, and especially in religion, which mark the Malays of the whole archipelago. Allowance too has to be made for the influence of the Chinese, perhaps also of the Japanese, on the tribes living on the coast long prior to the Spanish invasion. The inhabitants of the coast, the Malays of the second invasion, for the most part profess Christianity now, and are well known, but the pagans of the interior, the Borneo Malays, who, according to Prof. Blumentritt's theory, formed the first invasion, have never been thoroughly investigated, and this circumstance led Dr. Meyer to spend three months among the Igorrotos. The appendix in which he records his observations is very full. It discusses the name and extent of the Igorrotos, their territory, and its climate, their build, mode of dressing the hair, and tattooing (which is far more elaborate than that of even the Japanese grooms, and is probably the most complicated in the world), their dress, ornaments, weapons, villages, huts, agriculture, and cattle-breeding, food, and drink, domestic utensils, art, tools; customs at birth, and marriage, and death; their priests and religion; head-hunting, war customs, festivals, language, modes of reckoning time and numbers, and their myths and sagas. Finally comes Dr. Virchow's account of an Igorroto skull, and a brief vocabulary. It is this portion of the work which renders it one of scientific interest, and prevents it from being a mere amusing account of the modern grand tour. The numerous illustrations which it contains of the tattooing ornaments, utensils, and the like, add greatly to its value. The Igorrotos are among the disappearing peoples of the earth. They leave the impression of having once possessed a higher culture; their manufactures now are far below those of even half a century ago, and Dr. Meyer thinks that, like every primitive race brought into direct contact with European civilisation, nothing can save them from ultimate extinction.

LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.

[The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.]

Molecular Dynamics

I THINK there must be some mistake in Prof. Forbes' report of Sir Wm. Thomson's remarks as quoted in NATURE of last week (p. 461) upon the rate of wave-propagation on Maxwell's electro-magnetic theory of light. From the end of the last quotation one would suppose that Sir Wm. Thomson intended to convey that the rate of wave-propagation that Maxwell's theory asserted to be the same as that of light, was the rate of propagation of a variation of a current in a conducting wire. Now Sir Wm. Thomson cannot, I am sure, have intended to convey any such mistaken notion. Maxwell carefully guards against any such mistake by pointing out that conduction of electricity is of the nature of diffusion, and not of a wave-propagation, and so has no definite velocity. What Maxwell has calculated is the rate of propagation of disturbances in *non-conductors*, and not in conductors. It is the rate at which the disturbances, produced in the way considered by Sir Wm. Thomson in the preceding part of this quotation, would be propagated by transverse vibrations. Of course, as Sir Wm. Thomson asserts, something analogous to a longitudinal vibration may co-exist with these, but Maxwell's theory shows that a medium which would transmit only transverse vibrations would explain electric and magnetic phenomena.

GEO. FRAS. FITZGERALD

40, Trinity College, Dublin, March 23

[The passage quoted by Mr. Forbes is correctly reported. A more full explanation of this subject will be found in Nichol's "Cyclopædia," second edition, 1860, article, "Electricity, velocity of;" reprinted in vol. ii., art. lxxxi., of my collected mathematical and physical papers.—W. T.]

Civilisation and Eyesight

HAVING read with much interest the recent correspondence in NATURE on this subject, I am forwarding the results of some observations which I recently made to determine the degree of acuteness of vision possessed by the natives of the islands of Bougainville Straits, in the Solomon Group.

I examined the powers of vision of twenty-two individuals who were in all cases either young adults or of an age not much beyond thirty. For this purpose I employed the square test-dots which are used in examining the sight of recruits for the British army, and I obtained the following results:—Two natives could distinguish the dots clearly at 70 feet, one at 67 feet, two at 65 feet, three at 62 feet, four at 60 feet, two at 55 feet, three at 52 feet, four at 50 feet, and one at 35 feet. The conclusion at which I arrived was that 60 feet represented the average distance at which a native could count the dots—a distance rather greater than that at which they should be placed to test the normal powers of vision, viz. 57 feet.

Of these twenty-two natives I came upon only one whose vision seemed at all defective. In this instance—that of a man about thirty years old—the nature of the cause was sufficiently indicated by the prominence of the eyes and the nipping of the lids, especially when the sight was strained by trying to count the test-dots at a distance. The limit of distance at which this man could count the test-dots was 35 feet. The question which presented itself to my mind in this case was, whether a white man who could count the dots at the same distance—viz. 35 feet —would exhibit to the same degree the external signs of myopia. I might put this query into other words, and ask whether, considering the far-seeing powers of these natives, the peculiar external signs of myopia would not appear with a less degree of this defect than with the white man.

Natives of these islands are very quick at perceiving distant objects, such as ships at sea. I was often much impressed by their facility in picking out pigeons and opossums, which were almost concealed in the dense foliage of the trees some 60 or 70 feet overhead. My attention was not attracted by the unusual size of the pupils; the eyes, however, have a soft, fawn-like appearance with but little expression. In conclusion, I may refer to the circumstance that the interiors of their houses are always kept dark, the door being usually the only aperture admitting light. The object is, I belive, to exclude flies and other insects from their dwellings. Coming in from the direct sunlight, I have often had to wait a minute or two before my eyes became accustomed to the change; but the natives do not experience this inconvenience. Some hours of the day they commonly spend in their houses, while at night they use no artificial light except the fitful glare of a wood fire. It would seem probable that the influence of the opposite conditions, presented by the bright sunlight and the darkness of their dwellings, would be found in the increased rapidity of the contraction and dilatation of the pupil with the enlargement, perhaps, of the

retinal receiving area. It is, however, a noteworthy circumstance that these natives are able to pass from the bright tropical glare outside their dwellings to the dark interiors, and *vice versâ*, without showing the temporary derangement of vision which the white man experiences whilst the iris is adapting itself to the new condition. H. B. GUPPY

17, Wood Lane, Falmouth, March 30

Mr. Lowne on the Morphology of Insects' Eyes

IN reference to the discussion between Dr. Sydney Hickson and Mr. Benjamin Lowne, I beg to state that I have been favoured by both of those gentlemen with opportunities of carefully studying their preparations, and I feel it to be my duty to state that in my judgment Mr. Lowne's preparations do not justify the conclusions which he has based on them, and are, in fact, not made with that skill and knowledge of modern histological method which is necessary in order that trustworthy conclusions may be obtained. On the other hand, Dr. Hickson's preparations are thoroughly satisfactory as examples of histological manipulation. Dr. Hickson supports the accepted view as to the termination of the optic nerve-fibres in the nerve-end cells of the retinulæ. Mr. Lowne denies this connection. I have no doubt that such a connection cannot be readily observed in Mr. Lowne's preparations. At the same time I have no doubt whatever that this is because the preparations are badly made. Mr. Lowne's preparations fail to show many other simple features in the structure of the insect's eye, which are readily seen in preparations made by the application of methods now recognised and approved, but not made use of by Mr. Lowne.

I am sorry to see the resources of the Linnean Society employed in publishing a memoir the conclusions of which, although startling in their novelty, are undeniably based upon the mistaken interpretation of defective preparations.

I think it is important that the Fellows of the Linnean Society should know whether the memoir now published is the same which was read a year or two ago at the Royal Society, and whether the Council of the Royal Society took any steps to ascertain the value of Mr. Lowne's preparations, or came to any decision as to the fitness of Mr. Lowne's paper for publication.

March 14 E. RAY LANKESTER

On the Terminology of the Mathematical Theory of Elasticity

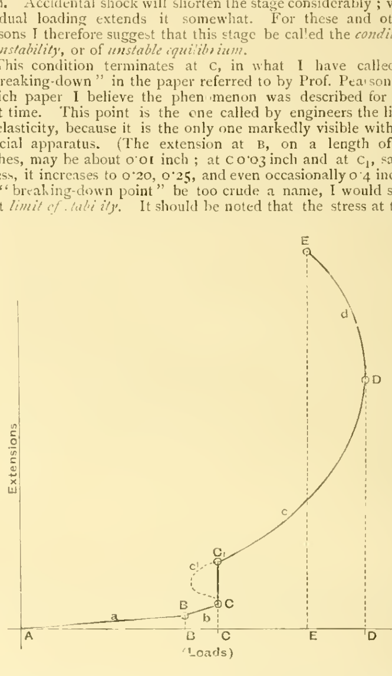
ENGINEERS quite as much as "elasticians" have reason to want some such terminology as that sought by Prof. Pearson (NATURE, vol. xxxi. p. 456), and have equal reason to be indebted to him for undertaking the work which he has at present in hand, which seems already to have given results of practical value as great as their scientific interest.

As I have for some years made a study of the physical side of the problems mentioned by him, I should be glad to make some suggestions as to terminology as contributions to the discussion of the subject in your columns. I will confine what I have to say to what may be called ductile materials (such as wrought iron, ordinary steel, copper, &c.), because in these only the whole phenomena are visible. The behaviour of such material in tension is illustrated by the accompanying figure, in which stresses are measured along the horizontal, and strains along the vertical axis.

It is extremely rare to obtain a piece of raw material already in a *state of ease*. *Wire*, of course, is highly strained by its process of manufacture, but that even ordinary bar and plate is also slightly strained, is shown in the manner mentioned by Prof. Pearson. Such initial strains as become visible as *set* by the first stretching up to any load (within limit of elasticity) disappear after one or two applications of that load. The material is then in a state of ease up to that load, but higher loads (still within the limit), on their first application, generally produce more set—the state of ease thus extending only to the stress employed to produce it. The *sets* are, along with the elastic strain, proportional to the stress, their effect being simply to lower the modulus of elasticity. Probably the process of *annealing* will bring the material into a state of ease for all loads at which such a state is possible. I propose to examine this matter further by aid, if possible, of the apparatus described by Prof. D. E. Hughes in the Inst. M. Eng. *Proc.*, 1883, p. 73. In the figure, *a* represents this *condition of perfect elasticity* (maximum state of ease being presupposed) and B, the superior limit of this condition, is the mathematical *limit of perfect elasticity*.

After B comes a stage *b*, within which the set is *not* proportional to the stress, although it still remains small; the total extension, therefore, increases faster than the stress. Occasionally this stage does not occur at all, and both its higher and lower limits seem—more than any other points in the life of the material—to be susceptible of change depending on manipulation. Accidental shock will shorten the stage considerably; very gradual loading extends it somewhat. For these and other reasons I therefore suggest that this stage be called the *condition of instability*, or of *unstable equilibrium*.

This condition terminates at C, in what I have called a "breaking-down" in the paper referred to by Prof. Pearson, in which paper I believe the phenomenon was described for the first time. This point is the one called by engineers the limit of elasticity, because it is the only one markedly visible without special apparatus. (The extension at B, on a length of 10 inches, may be about 0·01 inch; at C 0·03 inch and at C_1, same stress, it increases to 0·20, 0·25, and even occasionally 0·4 inch.) If "breaking-down point" be too crude a name, I would suggest *limit of stability*. It should be noted that the stress at this



point does not remain constant, but in reality appears to diminish as the extension goes on, as shown at *c'* (this dotted curve not drawn to scale), a matter on which I am at present experimenting. I should add that, during the application of load at this point, extension appears to be occurring at different parts of the length *successively*, and not at all parts simultaneously, as during conditions *a* and *c*.

In the next stage, C to D, the whole strains consist of a very small elastic portion (apparently closely following the modulus), and a very large set, increasing much faster than the stress. The test bar remains at each load practically constant in its cross-section at all points of its length, and rises in temperature instead of (as in condition *a*) cooling. I would suggest for this stage the name *condition of uniform flow*, the physical applicability of which will be obvious to any one who has seen ductile metal in this condition.

At some point, D, a maximum load is reached, and at *about* the same point (generally, I think, a little earlier, but the difference is small, and not very easy to get at with certainty) the metal begins to flow *locally*, a part becoming much more reduced in cross-section than the rest, and eventually fracture occurs at this place under a less load than D, but with a greater extension, as at E. This final stage, *d*, might be called *condition of local flow*. The loads D and E (as Prof. Pearson suggests) would be *maximum* and *terminal* loads respectively). (Their difference was first pointed out, I think, by Mr. Daniel Adamson's experiments, *Journal* I. and S. Inst., 1878). The maximum *intensity* of stress

occurs always, I think, at F, the cross-section of the bar being proportionately more reduced than the load.

ALEX. B. W. KENNEDY

University College, March 23

The Colours of Arctic Animals

THE white colour of Arctic mammals and birds has hitherto been generally ascribed by evolutionists to protective resemblance, the adaptation to a snow-covered country being attributed to the preservation of individuals which by assimilating to their environment in colour, either escaped detection by their foes, or, on the other hand, were by this means enabled to secure their prey more advantageously. Although a certain weight may, in the case of some species, be fairly given to these organic factors, it always appeared to me that this explanation was not in itself sufficient, in face of the consideration that many of the species so coloured could hardly be said to require such protection on account of persecution, or to derive any obvious advantage therefrom for predatory purposes. A more satisfactory explanation seemed to be that the mode of coloration in question had, at any rate in the first instance, been brought about by natural selection through physical rather than through organic agencies. It is well known that white, as the worst absorber, is also the worst radiator of all forms of radiant energy, so that warm-blooded creatures thus clad would be better enabled to withstand the severity of an Arctic climate—the loss of heat by radiation might, in fact, be expected to be less rapid than if the hairs or feathers were of a darker colour.[1] According to a paper recently published by Lord Walsingham,[2] it seems that this view was entertained as far back as 1846 by Craven,[3] the only addition to the theory required by modern evolution being that we must regard the white covering as having been acquired by the ordinary Darwinian process of the survival of the fittest, *i.e.* by the climatic selection of those individuals best fitted to withstand the extremely low temperatures of their habitat.

It is perfectly familiar to zoologists that most animals occasionally give rise to white varieties, so that the basic variations necessary for the establishment of the required modification in the colour of the hair and feathers would not have been wanting during the gradual approach of the Glacial Epoch. It may be conjectured whether white may not have been the prevailing colour among all warm-blooded animals during this period, with the exception, perhaps, of those species in which the severity of the climate may have been met by an equally effective thickening of the fur. Certain species which, like the stoat and ptarmigan, become white during winter, may, from this point of view, be regarded as reverting seasonally to the mode of coloration which in their ancestors was normal during the Glacial Epoch, the reversion being in these cases brought about by the same influences which formerly fixed white as the most advantageous form of covering. In accordance with this view, it is sometimes asserted that the stoat does not commonly turn white during winter in the south of England, excepting in very severe seasons.[4] Further observations on this point are much needed.

In striking contrast to the white covering of Arctic and Alpine mammals and birds, it has been found that there is a quite opposite tendency for the insects to become darker and more suffused, this melanism being especially noticeable among many of the Lepidoptera. Although numerous speculations as to the cause of this phenomenon have from time to time been advanced, it is in the paper by Lord Walsingham above referred to that what appears to be a true cause has for the first time been suggested. The author has, in fact, most ingeniously extended the very argument which had been adduced to account for the white colour of the mammals and birds to explain the quite opposite melanism of the insects. According to the present view the the melanic tendency of northern Lepidoptera must be ascribed to the natural selection of the darker forms owing to the advantage which these would possess in being able to absorb more of the solar radiation than their lighter congeners. The same action must be regarded as here bringing about opposite effects: in the case of warm-blooded animals the loss of heat by radiation is retarded by the white covering, whilst in insects, which develop but little heat by respiration, it is of the utmost importance to utilise as much as possible of the solar energy. This will be seen to be all the more necessary when it is considered that, under Arctic conditions, the solar rays have but little power, and that the pairing of the insects has to be effected with great rapidity. In order to test these views experimentally, the author exposed numerous species of Lepidoptera of various colours to the sun's rays on a surface of snow, and observed the rate at which the insects sank beneath the surface. As might have been anticipated, the darker insects, like *Tanagra chærophyllata*, sank more rapidly than white moths like *Acidalia immutata*, which made but little impression on the snow.

The questions raised by these suggestions and observations certainly appear to be well worthy of consideration when discussing the subject of animal coloration. Thus the explanation of the melanism of Arctic insects now advanced may perhaps, when more fully elaborated, throw further light upon the theory of seasonal dimorphism first proposed by Weismann.[1] If, in accordance with the views of this author, we regard the present winter forms of these seasonally dimorphic Lepidoptera as the ancestral Glacial types, it becomes clear why in such white species as *Pieris napi*, the parent Glacial form *Bryoniæ* should be the darker. In the case of *Araschnia levana* the theory does not at first sight apply, inasmuch as the winter form is lighter than the summer generation (*Prorsa*); here, however, both forms are coloured, and there would be but little difference in their relative heat-absorbing powers. The same remark may apply in the case of our own seasonally dimorphic species of *Selenia* and *Ephyra*.

R. MELDOLA

[1] *Trans. Essex Field Club*, vol. i. *Proc.*, March 20, 1880, p. vi.

[2] "On some probable causes of a tendency to melanic variation in Lepidoptera of high latitudes;" the Annual Presidential Address to the Yorkshire Naturalists' Union, Doncaster, March 3, 1885.

[3] "Recreations in Shooting," p. 101.

[4] R. M. Christy in *Trans. Essex Field Club*, vol. i. p. 67.

[1] I may take the present opportunity of pointing out to those who possess the English edition of the "Studies in the Theory of Descent" that an error inadvertently occurs in the numbering of the figures in Plate I. Figs. 2, 3, 4, and 5 should have been numbered respectively 3, 5, 2, and 4. I am indebted to Mr. E. B. Poulton for kindly calling my attention to this transposition.

An Error in Ganot's "Physics"

IN your issue of February 19 (p. 361), E. Douglas Archibald calls attention to a typical error in Ganot's "Physics," 10th edition, p. 325, and assumed that it had run through the ten editions. If he had taken the pains to look back to previous editions the formula would have appeared right, viz.:—

$$P = \frac{0\cdot31\ V(H - \frac{3}{8}FE)}{(1 + \alpha t)\ 760}.$$

In going over the text of earlier issues of the book some minor errors are discoverable, but do not detract materially from the value of the same to the careful student

FRANK E. EMERY,
1st Asst. Sci. Dept.

Mountainville, Orange Co., New York, March 4

WITH reference to the letter of Mr. Frank E. Emery on mine, calling attention to the typical error in Ganot's "Physics," I beg to say that though in some of the earlier editions the error may not exist, it occurs in the 5th and 10th, both of which are in my possession. The inference is very strong that if it occurs in these two it occurs in the editions *intervening*, and thus in HALF of the editions published. The first five editions are now getting out of date, so it is not of much value to people if the error does not exist in them.

I would also observe that if Mr. Emery takes the pains of reading my letter over again he will notice it was explicitly stated to be for the benefit of the large class of students who are *not careful*.

My purpose was in no way to run down Ganot, but to warn people of a pitfall in it.

E. DOUGLAS ARCHIBALD

Tunbridge Wells, March 23

Exceptional Whiteness in Tropical Man

SINGULARLY enough, being encamped in the same place as that from which the paper on "The Blackness of Tropical Man" was written to NATURE some months ago, the converse, a case of the whiteness of this class of man, presented itself unexpectedly. While entering, to-day, the native village of Jeykondasholapurm, that had sunk to nothing from having been the capital of a native dynasty in the south of India, and situated about lat. 11° N. and long. 78° E., the writer observed an apparently white woman sitting on a doorstep by the side of the road, with flaxen-coloured

hair, but having in other respects the characteristics of natives attacked by leprosy. Making inquiries from one of the principal native revenue officials at the place, it was ascertained that there was a family living hardly a mile away, of which more than one of the members had been born, and continued, white all their lives. That this did not result from their being lepers, and that none of their neighbours were in the least afraid of them, though opinion was not quite clear as to the whiteness not being disease.

Losing no time, it did not take long to reach the hut in which this family of albinos were to be found. They are of the Hindu blacksmith caste. The father and mother are stated to be of the ordinary blackness of natives of India, but were not seen on this occasion. A son, aged twenty-two, was there working at his trade, with the white colour, features, and light flaxen hair of a European, the only difference being a coarseness of the texture of the skin, and a slightly vacant expression. There was, beside him, an apparently elder brother, quite dark, and a native Hindu in every respect. It was said that albinos had occasionally appeared in the family, one of the uncles, for instance, having been white.

On being questioned as to whether there was any difference between the albinos and ordinary natives, it was at once said that the former could not stand being in the sun, which reddened and inflamed the skin, upon which the remark fell from the writer that it would be worth while to transport such individuals to a cold climate, where they would he exposed to no inconvenience. And so it would, because there can be no doubt that one of these white Hindus, early taken, and educated in a European climate, would from palpable observation of the specimen now described be absolutely indistinguishable as a native of India.

Evidently some cause has interfered with the production of pigment in the cells of the skin, with the effect of rendering the albinos highly sensitive, and more so than a European, to the invisible heat rays of the spectrum, which are so injurious to the constitution in India.

The contrast between the faces of the brothers was peculiarly striking, for there was sufficient resemblance, in the lower part of the face especially, to show there was a distinct relationship—that of the one who was dark wore the ordinary mild composure; but the other, by the mere change of colour, had completely and inadvertently thrown off the Oriental mask; and it would be almost impossible to convey to any one, not seeing it exemplified, how vast a change could be made by so simple an alteration, displaying the way the real individuality of race is lurking in an extraordinary manner beneath a tropical blackness.

India, February 24 A. T. FRASER

Far-sightedness

THOUGH I have already published a note on the subject in a Dutch paper (*Tijdschrift van het Aardrijkskundig Genootschap*, February, 1885), perhaps you will kindly allow the following lines to have a place in NATURE, because those who are occupied in the trigonometrical survey of British India may take an interest in the matter, and be able to give more particulars about it.

In a paper on Mr. Whymper's travels in Greenland, which appeared in *Ausland*, t. xii., 1884, I found in a foot-note the following remark:—"The reader might be astonished on hearing that I [Mr. Whymper] could see a mountain at such a great distance (about 100 English miles); but I may add that the day before I saw two other mountains 40 and 150 English miles distant; with one exception this was the greatest distance at which I have ever been able to make out objects."

Since I have not found any other reports in which it is expressly stated that objects were seen at a greater distance, I presume I may allege my own experience. While occupied with the trigonometrical survey of Western Java I sometimes had an opportunity of seeing objects at a very great distance, though, under the circumstances I was in, I had no time to look for them on purpose.

The greatest distance at which the angular points of triangles of the first order were from each other was about 105 kilometres; no difficulty ever arose from the distance, and no difference was made whether signals or heliostats (square mirrors of about 3 inches side) were observed.

When on Gng Karang (Bantam) I made out Keizerspick (Sumatra) at a distance of more than 110 English miles, though not quite easily, the top just peeping out from the slopes of Sebesic; if there had been a signal on Keizerspick at that time I think I could have observed it.

The greatest distance at which I remember ever to have seen an object was noted during my stay on Gng Tjikoraij (Preanger Regentsch), when I made out Gng Merapi (Java) most distinctly at a distance of about 180 English miles [1] and I suppose that Gng Lawu was also visible (225 English miles distant), but I could not quite distinguish it from the group of mountains of which it is one. It is, of course, from high summits that objects are seen at the greatest distances, and objects which are more elevated at a greater distance than such as are close to the ground.

I think it would be interesting to gather experiences referring to the subject made in different climates and under different circumstances. EMIL METZGER

Stuttgart, March 23

Krakatoa

SUPPOSING that the underground noises heard at Caiman-Brac on Sunday, August 26, 1883, were not only synchronous with, but actually the same as, those caused by the great eruption in the Straits of Sunda, it does not seem to follow that the sound-waves were propagated through the whole diameter of the earth. On the contrary, the question is at once raised, at what depth below the surface did the disturbances occur which found such destructive vent at Krakatoa? And if only the time-record east and west were accurate and satisfactory, there would seem to be some datum supplied for approximately estimating this depth. The centre of disturbance may have receded from and become inaudible at the Caimans in proportion as, on the 27th, it found final vent at Krakatoa. HENRY CECIL

Bregner, Bournemouth, March 30

The Recent Aurora

THE "Sunk" lightship is in electrical communication with the Essex coast, being connected thereto by a telegraphic cable 8·984 nautical miles in length, laid from Walton-on-the-Naze in an easterly direction. The electrical condition of this cable is ascertained daily at 10 a.m., by means of tests applied at the shore ends. Until the 15th inst. these tests were very regular and satisfactory, but on the morning of that day it was found to be impossible to obtain any satisfactory results, owing to electrical disturbances produced in the cable by some external influence. The electrician on board reported that the weather was very fine and summer-like, sea perfectly smooth, with variable light airs, and he could in no away account for the effects the electrician was observing on shore. Between 9 and 10 p.m. those on board the lightship observed in the northern sky a very brilliant aurora, from which at intervals two very bright columns extended upwards to the zenith, and there apparently joined.

I send you these particulars as they may be worth recording in connection with the aurora seen at Christiania on the same evening, and described by Mr. Sophus Tromholt in his letter to NATURE, published on the 26th inst. (p. 479). There can be no doubt but that the aurora seen at Christiania was identical with that noticed by the men on the lightship off Walton-on-the-Naze, and, although it was not visible until the evening, it was evidently affecting the electrical condition of the earth on the morning of that day, and was the direct cause of the electrical disturbance in the cable. Since that date the tests have been as satisfactory and regular as before. WILLOUGHBY SMITH

March 30

THE COSMOGONIC THEORY OF M. FAYE [2]

M. FAYE has expounded his theoretical views on cosmogony in the several publications named above, and in his book he has also treated of the historical development of cosmogonic theories. We shall in the present article confine our attention to that which is original in his speculation; and we recommend the

[1] In the junction of triangulations of Spain and Algiers the greatest side is about 270 kilometres.

[2] "Comptes Rendus," 1880, vol. xc. pp. 637 and 1246.
"Sur l'Origine du Monde" Pp. 257. (Paris: Gauthier-Villars, 1880.)
"Annuaire pour l'an 1885. Bureau des Longitudes." Pp. 757-804. (Gauthier-Villars.)

reader to refer to the essay in the "Annuaire" of the Bureau des Longitudes, 1885, for this portion of his work. M. Faye's writing is always easy and finished, and this essay has been intended for the general scientific reader. Had the original speculation been condensed for insertion in a purely technical journal it would have occupied but a few pages.

The earlier portion of the essay we may dismiss by saying that it gives a lucid exposition of the state of our knowledge of stellar systems, as derived from the spectroscope and the telescope, interpreted by aid of the principle of conservation of energy. In the following description of M. Faye's theory, we do not follow his words, but we believe that we give a fair interpretation of his meaning.

The best general idea of the line of speculation adopted may be given by saying that it is a theory of evolution from meteorites, instead of from the nebulous matter which gives its name to Laplace's theory.

In its primitive condition the Universe consisted of matter widely scattered in chaotic disorder. Currents were then generated in the midst of this chaos under the influence of mutual gravitation; and in consequence of these intestinal movements rags or shreds of matter became detached, and moved with rapid linear and slow gyratory motion.

It is not claimed that the existence of these currents can be explained, but the spectroscope affords evidence of a sorting process, for some nebulæ consist of a single gaseous element, whilst the stars with continuous spectra consist of a great diversity of elements.

The various modes are sketched in which one of these shreds may proceed to agglomerate and evolve itself, but we shall not follow M. Faye in the application of his theory to the formation of nebulæ, double-stars, and star-clusters.

The solar system is taken to have originated from a shred which aggregated into a spheroidal shape, and consisted, at the epoch when we begin to watch it, largely or principally of separate meteorites. The spheroidal aggregate possessed a considerable amount of rotation moment of momentum), about an axis approximately identical with the axis of the sun's rotation.

It is at first supposed that the spheroidal aggregate consists of matter pretty nearly equally distributed throughout its volume, and later a nucleus is formed. If r be the distance of any point from the centre, the force is central, and follows the law $a\,r + \frac{b}{r^2}$, where, in the beginning of the evolutionary process, b is very small, and later a becomes small.

Initially, then, when the force is simply as the distance from the centre, each meteorite moves in an ellipse about the centre, and the periodic time of all of them is the same, whatever their eccentricity of orbit. Those meteorites whose orbits are decidedly eccentric, cross the orbits of many others, and have much less chance of escaping collision than those whose orbits are nearly circular. In consequence of collisions, a central nucleus is soon formed, and then many meteorites with very eccentric orbits begin to strike against it, and to be absorbed into it. As the nucleus increases the a in our formula for the force diminishes, and the b increases; but orbits which are circular still retain that form, notwithstanding the progressive change in the law of force.

At the same time that the nucleus is being formed, a series of flat and nearly circular rings arise around it, those near to the nucleus attaining a definite shape sooner than the remote ones. It is not adequately explained why the matter should be sifted, and should arrange itself in rings at definite intervals around the nucleus; still less is any light thrown on the law of Titius concerning the distances of the planets from the sun. Nor do we see why the rings should first be formed nearest to the nucleus. We must, however, here follow M. Faye and accept these conclusions.

If there be only a small nucleus (b small), each ring revolves with very small relative motion of its parts; whilst if the nucleus be large (a small), each meteorite in a ring revolves after Kepler's laws, and the bodies in the external margin have a slower angular velocity than those in the internal margin. As the nucleus gradually increases there will be a transition from one mode of motion to the other.

Now let us follow the first ring: Slight differences of angular velocity, mutual attractions between the parts of the ring and collisions gradually cause the aggregation of all the matter in the ring around some centre in its line. When the nucleus is small the ring moved as a rigid whole, and the linear velocity of the outer meteorites was greater than that of the inner ones, therefore when the planetary aggregate is formed it will be found rotating with direct motion about an axis nearly perpendicular to the plane of its orbit.

Whilst the first ring is agglomerating into a planet, a second ring is being formed outside of it, and this in its turn agglomerates; but the tendency to direct rotation is weaker than in the first planet, because the increase of the solar nucleus by absorption of meteorites has prevented so large an excess of linear velocity of the outer meteorites over that of the inner ones as in the first case.

The process continues and the planets are successively formed, until we come to an epoch when the nucleus has increased so far that on agglomeration the tendency to direct rotation vanishes—the constituent ring, in fact, revolved irrotationally.

Still further we come to planets in which the meteorites move nearly according to Kepler's laws, and here the resulting planet has a markedly retrograde rotation. Each planetary agglomeration in its turn forms a miniature solar system, and generates satellites by the same process as that in which the planets were formed.

We have now sketched this theory in its main outlines, and must refer the reader to the original sources for further details.

Neither in the historic part nor in his cosmogonic speculations does M. Faye make reference to the possible effects of tides in the evolution of the solar system, perhaps thinking that a theory founded on that influence is not even worthy of mention. It is, however, a factor which cannot be left out of account. Tidal friction is a *vera causa*, and the possible effects on our evolution have been submitted to a rigorous quantitative examination.[1] As it is the only cosmogonic influence which has hitherto been so treated, the results to which it points are at least as worthy of attention as those of other vaguer influences.

The hypotheses that tidal friction has had free play in the past leads to a remarkable quantitative coordination of the several elements of the earth's rotation, and of the moon's orbital motion, and points to the genesis of the moon close to the present surface of the earth. No phenomenon in the heavens could have been devised more perfectly apt to confirm the truth of the hypothesis than the rapid orbital motion of the inner satellite of Mars. Near to the sun solar tidal friction would be much more powerful than at a distance, and thus the rotation necessary for the manufacture of satellites would be destroyed in the vicinity of the sun; a light is thus thrown on the cause of the observed distribution of satellites in the system.[2]

It has, however, been decisively shown that tidal friction cannot have played the leading part either in the evolution of the whole solar system or of the remoter

[1] We refer to a series of papers by the present writer on this subject in the *Phil. Trans. Roy. Soc.* from 1878 to 1882.

[2] This theoretical effect of tidal friction has not been commented on by any writer. Further numerical details and discussion will be found in *Phil. Trans.*, Part ii, 1881, p. 531.

planetary systems, and whilst the field is thus left open to the nebular hypothesis or other rival theories, it is submitted that tidal friction has a bearing on those theories which cannot be neglected.

A numerical comparison of the distribution of moment of momentum amongst the several planetary sub-systems shows that the terrestrial system differs considerably from all the others, but it would hardly be logical to postulate an absolutely independent mechanism in this case, and it is not very easy to reconcile the genesis of the moon close to the earth with the formation of a ring in the midst of a planetary agglomeration of meteorites. Let us now summarise the advantages and disadvantages of M. Faye's scheme.

The conception of the growth of planetary bodies by the aggregation of meteorites is a good one, and perhaps seems more probable than the hypothesis that the whole solar system was gaseous, and that the influence of hydrostatic pressure was felt throughout. The internal annulation of the meteorites is left unexplained, and this compares very unfavourably with Laplace's system, where the annulation is the very thing explained. The difference of orbital motion of the inner and outer meteorites of a ring, the development of that difference as time progresses, and the consequence of direct and retrograde rotation at different distances from the sun is an excellent idea. But it is necessary to this idea that the inner planets should have been formed the first, and we are met directly by the fact that the single surviving ring, that of Saturn, is nearer to the planet than are the satellites. It is, of course, possible that special causes have preserved this ring, but we should be driven to the startling conclusion that Saturn's ring is the oldest feature of his system.

The actual distribution of satellites in the solar system is at variance with M. Faye's theory, for, according to him, the internal planets were generated from rings whose motion was such as would give greater moment of momentum to the planetary agglomeration than would the external ones. The number of satellites manufactured should be greater the greater the amount of rotation in the primitive agglomeration of meteorites, and thus the nearer planets should be richer in satellites than the remote ones.

The celebrated experiment of Plateau, in which a drop of oil rotating in alcohol and water is made to parody Laplace's solar system, is worthy of attention, and it tells against Faye and in favour of Laplace. It is of course to be admitted that surface-tension does not duly represent gravity.

On the whole, then, we must hold the opinion that there are great difficulties in the acceptance of M. Faye's theory, notwithstanding its excellences. The time does not appear yet ripe for definite judgment on this very complex subject, but science is undoubtedly the gainer by such suggestive theories. Whilst a false statement of fact always proves a serious detriment, the enunciation of false or partially true theories is always the incentive to, or initiation of, the discovery of truth.

G. H. DARWIN

SIR WILLIAM THOMSON ON MOLECULAR DYNAMICS [1]

II.

IN the present article Sir William Thomson's spring and shell molecule will be described and its theory sketched, in so far as this has been investigated with the view of getting over some of the difficulties which surround the wave theory of light. In Helmholtz's memoir on anomalous dispersion, a sketch of such a theory was published. But this new molecule differs from that of Helmholtz in several points, chiefly in the fact that absorption is not accounted for by any viscous action in the molecule dissipating the energy of vibration into low grade heat. Most readers who have ever visited the natural philosophy lecture-room in Glasgow University will recognise a very old friend in this new molecule, where they have seen it vibrating, I suppose, any time since the University occupied its present site. In appearance the molecule has been changed, but its theory as taught to the students there is identical. For a description of this molecule let us refer to page 10 of the lectures:—

"Imagine for a moment that we make a rude mechanical model. Let this be an infinitely rigid spherical shell; let there be another absolutely rigid shell inside of that, and so on, as many as you please. Naturally we might think of something more continuous than that, but I only wish to call attention to a crude mechanical explanation possibly of the effects of dispersion. Suppose we had luminiferous ether outside, and that this hollow space is of very small diameter in comparison with the wave-length. Let zig-zag springs connect the outer rigid boundary with boundary number two. I use a zig-zag, not a spiral, spring which has the helical properties which we are not ready for yet, such properties as sugar and quartz have in disturbing the luminiferous vibrations. Suppose we have shells two and three also connected by a sufficient number of spiral springs, and so on; and let there be a solid inclosed in the centre with spring connections between it and the shell outside of it. If there is only one of these interior shells, you will have one definite period of vibration. Suppose you take away everything except that one interior shell; displace that shell and let it vibrate. The period of its vibration is perfectly definite. If you have an immense number of such shells with moveable molecules inside of them, distributed through some portion of the luminiferous ether, you will put it into a condition in which the velocity of propagation of the wave will be different from what it is in the homogeneous luminiferous ether. You have what is called for, viz. a definite period; and the relation between the period of vibration in the light considered and the period of the free vibration of the shell will be fundamental in respect to the attempt of a mechanism of that kind to represent the phenomena of dispersion.

"If you take away everything except the one shell, you will have almost exactly, I think, the view of Helmholtz's paper—a crude model as it were of what Helmholtz makes his paper on anomalous dispersion. Helmholtz, besides that, supposes a certain degree or coefficient of viscous resistance against the vibration of the inner shell, relatively to the outer one. Helmholtz does not reduce it to a gross mechanical form like this, but merely assumes particles connected with the luminiferous ether and assumes a viscous motion to operate against the motion of the particles."

In the lectures the action of such a molecule when subjected to forced vibrations was illustrated by a model of ingenious construction, which among the irreverent passed by the name of the "wiggler." A steel wire was hung vertically, and five or six lathes 2 feet long and 2 inches wide were attached in a horizontal position to the wire, each one having three pins fixed in it for this purpose. These lathes were loaded at their ends, the weight on each lathe being less than that on the one above it. The lowest lathe was attached to a pendulum arrangement which impressed forced vibrations upon the system, the period being adjustable. The theory of such a system is the same as that of the molecule described above.

But in working out the theory a third type of vibrator was used, the identical one which vibrates in the lecture room at Glasgow. This is a series of weights attached to each other by vertical springs which can be stretched. The highest is the heaviest, and the others are arranged in the order of weight.

[1] Continued from p. 463.

Calling P the lathe with forced vibrations (corresponding to the external massless shell acted on by the ether), and ξ its displacement, m_0, m_1, &c., are the successive masses, x_0, x_1, &c., are their displacements

$$u_2 = -\frac{c_2 x_1}{x_2},$$

and measures the relative displacement of m_1 and m_2. c_1, c_2, &c., are the constants of successive spring connections. $c_2(x_1 - x_2)$ is the force of restitution in virtue of the spring connection between x_1 and x_2. τ is the period of forced vibration.

We thus arrive at the equation

$$\frac{du_i}{d\tau} = -\frac{2}{\tau^2} \cdot \frac{1}{x_i^2} m_i x_i^2 + m_{i+1} x_{i+1}^2 + \ldots + m_j x_j^2),$$

and since the right hand member is essentially negative, it follows that all the u's diminish with increase of period. The critical cases occur when the period of forced vibration agrees with the natural period of any of the shells or lathes. When the forced vibration is very rapid, all successive masses move in opposite directions. When the forced period is slower, u_1 becomes zero, and x_1 is infinite—*i.e.* the vibration of the lowest mass is infinite in comparison with the forced vibrator, and so with the other vibrators. When the forced period is slower, u^1 becomes negative, *i.e.* the lowest mass begins to vibrate in the same direction, as the forced vibrator. Successive critical cases occur as the forced period reaches the natural periods of successive vibrators. At the critical period for any one vibrator, all those below it are vibrating in one direction, while the critical one and those above it are executing very large vibrations in opposite directions successively.

These critical periods are admirably adapted for explaining absorption and also anomalous dispersion. In highly absorbing media which cut off a band of light from the spectrum, the refractive index for colours neighbouring to the band is remarkable; thus light of greater wave-length than the band is refracted more, and light of less wave-length than the band is refracted less than in normal substances. Lord Rayleigh considered this to be due to the mutual influence of the vibrating molecule and ether. If the point of support of a pendulum is vibrated in a different period, the period of the pendulum is changed. Lommel seems to have been the first to make dispersion depend upon associated matter.

The influence of a large number of the spring and shell molecules distributed through the ether upon the velocity of light in that medium is examined and shown to depend upon the wave-length or period. Finally at p. 103 we obtain the following formula:—

$$\frac{\tau^2}{\lambda^2} = \frac{1}{l}\left[\rho - c_1\tau^2\left\{1 + \frac{c_1\tau^2}{m_1}\left(\frac{\kappa_1^2 R_1}{\kappa_1^2 - \tau^2} + \frac{\kappa_2^2 R_2}{\kappa_2^2 - \tau^2} + \ldots\right)\right\}\right].$$

ρ and l measure the density and rigidity.

$$R_1 = \frac{\text{Energy of } i\text{th shell}}{\text{Energy of the whole}}.$$

κ_1 = the ith critical period.

"This is the expression for the square of the refractive index, as it is affected by the presence of molecules arranged in that way. It is too late to go into this for interpretation just now, but I will tell you that if you take τ considerably less than κ_1 and very much greater than κ_2 you will get a formula with enough disposable constants to represent the index of refraction by an empirical formula, as it were, which from what we know, and from what Sellmeier and Ketteler have shown, we can accept as ample for representing the refraction index of most transparent substances. We have the means of extruding its powers and introducing the effects of those other terms, so that we have a formula which is more than sufficient to give us a mathematical expression of the refrangibility in the case of any transparent body whose refrangibility is reliable."

In fact the above formula is equivalent to the well-known formula of Cauchy and others, viz.

$$\mu = \mu_0\left(A + \frac{B}{\lambda^2} + \frac{C}{\lambda^4} + \ldots\right)$$

when we are not dealing with critical cases. Examining the formula for $\frac{\tau^2}{\lambda^2}$ or μ^2, we see that as τ approaches κ_1, μ^2 becomes infinite, and for τ a little greater than κ_1, μ^2 is negative, which is impossible, and we can have no assignable velocity for such a period—*i.e.* there is absorption for all values of $\tau > \kappa_1$, which make μ^2 negative. Moreover, owing to the existence of a critical period, κ_1, the refractive index is abnormally increased for values of τ which are just less than κ_1, and it is abnormally diminished just when μ^2 becomes positive. This means that the refrangibility of rays in a highly absorbent medium, in the neighbourhood of the band of absorption, is anomalous in the direction indicated by Kundt in his researches on anomalous dispersion. Here is what we find at p. 150 on critical values of τ and the manner of absorption:—

"We shall try to see something more of the effect of light propagated through a medium of a period exactly equal K_1. I believe each sequence of vibrations will throw in a little energy which will spread out among the different possible motions of the molecule. The combination of the sequences, forming what we call continuous light, is not a continuous phenomenon at all. I believe that the first effect when light begins will be: each sequence of waves of the exact period throws in some energy into the molecule. That goes on until, somewhere or other, the molecule gets uneasy. It takes in an enormous amount of energy before it begins to get particularly uneasy. It then moves about, and begins to collide with its neighbours perhaps, and will therefore give you heat in the gas, if it be a gaseous molecule. It goes on colliding with the other molecules, and in that way imparting its energy to them. The energy will be simply carried away, by convection if you please, or a part of it perhaps. Each molecule set to vibrating in that way becomes a source of light, and so we may explain the radiation of heat from the molecule after it has been got into the molecule by sequences of waves of light. I believe we can so explain the augmented pressure of a gas due to the absorption of heat in it.

"We may consider, however, that the chiefest vibration of the molecule is that in which the nucleus goes in one direction, and the shell in the opposite direction, but with a great amount of energy in the interior vibrations and very little in the shell, so that the shell may go on giving out phosphorescent energy for two or three hours or days, simply vibrating for ever, except in so far as the energy is drawn off and allowed to give motion to other bodies."

A great deal more is said about the influence of critical periods upon anomalous dispersion, but, as the author says, "it is like fiddling when Rome is burning to discuss anomalous dispersion when double refraction is waiting to be explained," so I will pass from this subject.

We have in the lectures some indications of the effect of introducing a gyrostat inside the shell molecule, especially with relation to magnetic rotation of the plane of polarisation. On this subject the author said sadly: "But alas! my results give me another law, not more effect with greater frequency, but less effect with greater frequency, according to the inverse square of the wave-length. I therefore lay it aside for the present, but with perfect faith that the principle of explanation of the thing is there" (p. 244).

But, on returning to this country, a more complete theory of the gyrostatic molecule was worked out, sent to

America, and incorporated in the lectures. In my next and concluding notice I shall touch on the further developments if space permits.[1] GEORGE FORBES

(*To be continued.*)

CITY AND GUILDS OF LONDON INSTITUTE

THE Fifth Annual Report of the Council of this Institute, which was presented last week to the Governors by the Lord Chancellor, gives evidence of marked progress in all departments of the Institute's operations. During the last five years, the advance made in this country in providing technical schools of various grades has been very great, and brings us educationally within a measurable distance of France and Germany. Much praise is certainly due to the City Companies for the very energetic manner in which they have set about giving effect to the important objects they have undertaken. The Technical College at Finsbury and the Central Institution at South Kensington are important additions to the educational establishments of the metropolis. That the Finsbury College has supplied a great want is shown by the rapid increase in the number of students during the two years since it was opened. The number of evening students might have been expected to be large, because in very few places, if in any, do evening students have the same advantages as at Finsbury of obtaining practical instruction in physics and mechanics. But the great success of the College is shown in the increasing number of its day students. In little more than two years the number has increased from 30 to 148; and nearly all these students are in regular attendance throughout the whole day, and go through the complete course of instruction as laid down for them in the programme. Some changes have taken place in the staff of the College in consequence of the opening of the Central Institution. Mr. Philip Magnus has been relieved of the duties of Principal, which he temporarily undertook in addition to his other duties as organising Director of the Institute, and Profs. Ayrton and Armstrong have resigned the Chairs of Physics and Chemistry for similar positions at the Central Institution. The appointment of Dr. Silvanus Thompson as Principal and Professor of Physics at Finsbury promises well for the future of the College, and the Council have been well advised in this selection. The Professorship of Chemistry is still vacant.

The Central Institution, which is to form a kind of technical university, was formally opened in June last, but, as generally happens, the completion of the fittings has occupied more time than was anticipated, and the Institution is consequently not yet in working order. The Prince of Wales, who has shown great interest in the progress of the Institute, issued an appeal to the Lord Mayor and to the Masters of the several Companies for additional funds to defray the cost of the fittings, which brought in over 17,000*l*. It may be expected, therefore, that this Central College will be very completely furnished with all the necessary appliances and apparatus for scientific and technical instruction.

The Council of the Institute refer with satisfaction to several passages in the Report of the Royal Commissioners on Technical Instruction, showing the great need in this country of improved facilities for higher technical teaching. It is a common error, which the building in South Kensington will help to correct, that technical education has reference to artisans only, and that the improvement of the skill of the working man is the great *desideratum* in the commercial interests of the country. But this is not so. The difference between foreign countries and our own in the facilities afforded for the education of artisans is not so marked as in the opportunities for the higher education of masters and managers of works.

But the City Guilds Institute, whilst giving prominence in its scheme to the provision of this higher education at its Central Institution, has done a great work in assisting in the establishment of evening technical schools in all the principal manufacturing centres of the kingdom, by means of its system of technological examinations. The Director's special Report on this part of the Institute's work is full of detailed information as to the increase in the number of candidates and of subjects of examination, and is supplemented by remarks of the examiners on the causes of the failures of the candidates. The percentage of failures is decidedly high; but the Institute very wisely insists upon a high standard of excellence, so that its certificates may be accepted by masters and employers as proof of the efficiency of those who hold them. In many crafts, this would be impossible, if the certificates were awarded on the results of a written examination only; but the practical tests which have this year been added afford a guarantee, which would otherwise be wanting, of the technical skill, as well as of the knowledge of the candidates. In the examination in "weaving," for instance, the candidate is required to design an original pattern, to prepare it for the loom, and to weave it in suitable material, besides answering questions on the analysis of patterns, the structure of the different kinds of looms, &c. In mine surveying, also, a practical examination was last year held at the Pease's West Collieries, in which the candidates were engaged, with the examiner, in surface and underground work during the three days. Whilst the Institute's examinations are thus conducted there can be no doubt of their efficiency, and of their affording a valuable supplement to those of the Science and Art Department. Most of the Institute's examiners complain of the candidates' want of skill in drawing; and it is satisfactory to note that the attention of the Education Department has been called to this general defect in the education given in our primary schools, and that it is likely to be remedied by the provisions for teaching linear drawing throughout the Standards contained in the New Code for 1885.

The Report of the Institute concludes with an appeal for additional funds. If the Council are to develop the work they have begun they require a much larger income than they now dispense. A good beginning has been made, but it is little more than a beginning, in the establishment of technical schools in this country. Leicester, Nottingham, Sheffield, and Manchester have received some assistance from the Institute; but there are many manufacturing towns still requiring help, and the wants of the metropolis are by no means satisfied. It is to be hoped, therefore, that the appeal of the Council, backed by the powerful support of the Lord Chancellor, will meet with a ready and adequate response.

THE PEABODY MUSEUM AT NEW HAVEN, U.S.

THE accompanying illustration of this fine museum is reproduced from *Science*. The Peabody Museum, Mr. Ingersoll informs us, stands on the corner of Elm and High Streets, just without the *campus* of Yale College. The building is due to the liberality of George Peabody, who gave a sum of money, in 1866, to erect a house for the collections. Thanks to the financial prosperity of Massachusetts, the bonds for a hundred and fifty thousand dollars had greatly increased, and those set aside for the first wing of the building had become worth a hundred and seventy-five thousand dollars when the trustees began to build. With that sum they have erected one of the finest buildings, for its purpose, in the United States—a lofty and ornamental structure of red brick and cream-coloured stone, whose broad and numerous windows

[1] Corrections to first notice in issue of March 19:—For *asphasia* read *aphasia*. P. 462, line 41 of second column, for *a few seconds*, read *for a few thousandths of a second*. P. 463, line 35 of first column, for *without* read *with*.

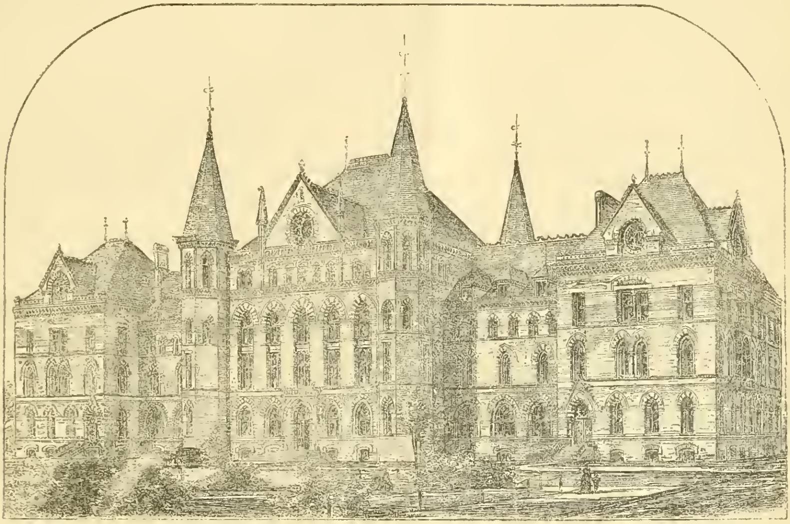
express the desire of the investigators within for all the light they can get.

Entering the basement-floor we find the possessions of the U.S. Fish Commission, deposited for sorting and examination under the eye of Prof. A. E. Verrill, who is chief of the zoological part of the museum, or by some of his associates. In another part of the basement, Prof. O. C. Marsh keeps "greate store" of fossils, cleaning the gigantic bones from Rocky Mountain quarries preparatory to study and display. Considerable palæontological property of the U.S. Geological Survey is under inspection here also.

Only favoured visitors go to the basement, or care to go. The public entrance is above, opening underneath a magnificent rose-window into a spacious court with tiled floor, and walls of variegated bricks. This region is garnished by great slabs of the celebrated footprint sandstones from the Connecticut valley, and a huge stump taken entire from a coal-bed. Iron staircases, clinging to the wall in spiral flight, lead to the top story, and the court is roofed with glass. On the right and left of the entrance are doors leading to business offices, the blowpipe laboratory, and the lecture-rooms of the Professors Dana (father and son), where large audiences frequently gather to hear the instruction designed for undergraduates alone ; and in the rear of the court, on the ground-floor, is the exhibition hall for minerals, of which the museum possesses an almost unrivalled collection. This might be expected, considering the men—Dana, Silliman, Brush, and others—of whose labours it is the result.

The only thing in this room not locked up is a meteorite weighing 1600 lbs. The metal in one spot has been sawed off, and polished until it looks like burnished steel, and has been engraved with an historical inscription, from which it appears that this meteorite fell in Texas, presumably the only State in the Union large enough to receive it safely.

After the brilliant and many tinted ores, the endless



The Peabody Museum as it will appear when completed.

variety and beauty of the quartz crystals, and the substantial interest inspired by the metals, visitors always pause with new gratification before some curious rosetted crystals of a form of lime, though they usually quite overlook the "educational series," which has been spread with such pains for their instruction. This educational collection, which seems to be extremely apt and well selected, concentrates in a single case a practical glossary and text-book of mineralogy. To this epitome of the science all the rich and rare examples in the wall-cases are only attractive illustrations ; and, the further to help the inquirer to understand them, several copies of Dana's "Mineralogy" will be found upon little tables near by. Here persons may sit and read, acquire and carry away the information, but not the *book*, for that is chained to an iron pillar.

The third floor is that most popular with the public, since it is devoted chiefly to modern animal life. The first thing to strike the eye in the south room is a fine series of comparative skeletons of primates, from civilised man down to the humblest of monkeys, all hanging in a beautiful row by hooks screwed into the tops of their heads. Beyond them, the whole side of the room is filled with cases containing an orderly succession of skeletons illustrating all the vertebrate orders ; while the centre of the room is occupied by the skeletons and stuffed hides of the larger mammals, like the camel, rhinoceros, a very dejected polar bear, &c.

In the same room several cases are filled with stuffed skins of mammals, birds, and reptiles. Beside most of the land birds are placed their nests, with the eggs ; or else the eggs are glued upon upright tablets of ground glass, in which position they show to excellent advantage. One large case is devoted to a collection of New England birds alone, excellently mounted upon the branches of a tree. This is the work of Prof. W. D. Whitney, who, before he became prominent as a linguist, was known as a good ornithologist ; as, in fact, he still is.

Passing to the west room on the same floor, one sees invertebrate preparations most attractively displayed.

They are confined almost wholly, however, to the crustacea, mollusks, radiates, and marine protozoa. Of insects there is a very small showing—only enough to represent scantily the classification of that immense class. This is partly because it is unwise to display insects freely, since exposure to the light causes their colours to fade, but is due chiefly to lack of material, owing to the fact that no entomologists of note have been especially interested in the progress of this museum.

On the other hand, the special tastes of Profs. Verrill, S. I. Smith, J. H. Emerton, and others, and the intimate relations the Museum (through these gentlemen) have sustained with the Smithsonian Institution and the U.S. Fish Commission, have brought the department of marine invertebrates to an almost unrivalled perfection. In no room does the casual visitor linger longer than in this one; while its contents are unusually interesting to specialists, because of the large proportion of type-specimens included. In many instances these are unique; as, for example, some of those beautiful orange and scarlet gorgonias or "sea-fans"—flat, branchless, mossy growths of calcareous matter, which resemble great masses of pressed seaweed. One case is wholly filled with these corallines; and it is doubtful whether any museum in the world can make a better showing of them.

The corals, also, are very fine, embracing many rare and even unique forms, as might be expected, remembering Prof. J. D. Dana's labours in that direction: so that only the Museum of Comparative Zoology equals this part of the cabinet.

In the way of deep-sea forms of crustaceans, and echinoderms also, a great number of novel species are publicly displayed, which were procured in recent dredgings by the Fish Commission. Among them stand large jars holding alcoholic remains of the giant cuttle-fishes upon which Verrill has written so many learned pages; and overhead hang Emerton's paper models of Architeuthis and a huge octopus, which half the visitors take to be real devil-fishes stuffed, and gaze at with fearful curiosity.

The remaining rooms on this floor are occupied as laboratories or lecture-rooms by Profs. Verrill and Smith, of the Sheffield Scientific School.

The fourth story contains storerooms filled with fossils, a collection (on exhibition) of about two thousand antiquities of great value from Central America, and a fair show of archæological relics, the most notable part of which is the pottery from the mounds of the Ohio valley.

But the glory of the Yale Museum is its palæontological treasures, brought together wholly by Prof. O. C. Marsh. The few representatives of this collection visible in the second-floor rooms and in the hall-ways are alone sufficient to stamp the museum as pre-eminent in this line; but they are merely an advertisement of what cellar and attic contain. It is not too much to say that, in respect to vertebrate palæontology (outside of fishes), this museum is not surpassed in the world. Where other collections own fragments or single skeletons, Prof. Marsh boasts scores or hundreds of individuals, while many extinct races are known only by their fossil remains in his possession.

This is the result of wisely-directed energy, and the ability to spend money promptly and liberally. Marsh's frequent expeditions to the far west are well known to geologists. Many car-loads resulting from these were not only shipped home by himself, but his agents have been forwarding enormous quantities ever since from Wyoming and Colorado "quarries."

To Prof. Marsh's personal collection somewhat has been added at the museum by the U. S. Geological Survey, which will become the publisher of the outcome of his studies now in progress. A score or so of assistants are constantly on duty, either in study, or in the mechanical work of skilfully extracting fossils from the rocky matrix; in matching and mounting, by the aid of wire, clay, and plaster, for permanent preservation, the often badly-broken bones of some antique brute whose extinction most of the world can accept with resignation; or in making casts, models, and drawings of fossils, original and "restored."

Several quarto volumes are already under weigh, and scarcely an issue of the *American Journal of Science* appears without an advance note of some special discovery in vertebrate palæontology, anticipating the completer descriptions to be made from this museum's rich materials.

NOTES

The new Lord Rector of Glasgow University, Dr. Lushington, was installed on the 26th ult. The address, which was in every way worthy both of the University and of the Lord Rector, contrasted strongly, with its calm, deep utterances and its grasp of the needs of a complete academic life, with the more or less political utterances to which we have been too much accustomed on similar occasions. We give the following quotation touching scientific work at a University:—"Communion of mind with mind is the most powerful help to mental growth, calling forth and expanding the intellectual powers which it is the duty of every free man to cultivate; in such intercourse he who gives receives, and is made richer in giving what awakens new life in another. By fellowship of this kind toil is sweetened and obstacles overcome. What is the history of the greatest inventors and discoverers the world has seen, but a firm defiance of difficulties and discouragements? And who that ever honestly faced any difficult problem, and 'oft foiled, oft rose' in the struggle has failed to gain at last the meed of hard-won victory? The rapture of Balboa, when from a peak of Darien he first gazed on the Pacific, is even less touching than that austere joy, of contemplation destined to those who by steadfast and painful efforts, long seemingly unrewarded, have wrested from nature some hitherto unguessed secret, some truth which illumines and brings into closer union other familiar but as yet unconnected aspects of knowledge. When, after years of doubtful poring, the light flashed upon Newton which was for ever to make clear to man the dynamics of the heavenly bodies, showing how the same law sways every leaf that flutters in the gale and the remotest star-clusters, we can well conceive how the ecstacy of wonder and delight was a disturbing presence that overpowered him, and made him request a friend to finish the calculation he had begun. And every generation, every decade, almost every year, opens new vistas through which the piercing eye, armed with weapons inherited from earlier conquests, may look forward bright in the hope of adding something more to the store of accomplished good to mankind; for in knowledge, as in nature, nothing is unfruitful. Such hope cheered and upheld many daring pioneers of science, whose venerated names, now become household words, are linked together for ever in the history of human progress, known and honoured throughout the whole civilised world. Yet who in the age of Watt, even in the boldest flights of presaging imagination, could have foretold such wondrous conquests over space and time as the spectroscope, the electric telegraph, and the telephone have revealed? But I forbear from dwelling longer on the incentives to exertion held out to all by the numerous physical sciences which have so many gifted exponents, before whom it becomes a non-expert to be rather a listener than a speaker. May all honour and success be theirs in sounding the mysterious depths of nature, and drawing into light the essential order which underlies her seeming complexities, ruling them with the necessity of intelligible relations. Many and various are the marvels with which "the world of eye and ear" surrounds us, inviting adventurous search into their far recesses; but as human thought advances, winning ever wider triumphs in solving riddle after riddle, must not the further

question force itself upon us, What of this power which reads and interprets nature? Beside and beyond the outward and visible, linked to it by mysterious connection, is the sphere of thought, of mind, the home and dwelling-place of thought. What is this being of ours which thinks, plans, and wills? What means it? Whither tends it? This, the question of questions, from far distant periods, souls possessed with profound genius have dared to ask and yearned for a reply. When no complete reply was gained, they yet toiled on, finding in the search food for deeper and more reverent wonder than even in the splendid picture which outward nature displays. They held fast the courageous and hopeful faith that for man who 'names the name Eternity,' 'there must be answer,' here or elsewhere to his trembling doubt, to his 'obstinate questionings.' Such searchers were the early Greek philosophers, who kindled a spark amid surrounding darkness, destined not to die out, but gradually to brighten by careful tendance, and grow into a light that will shine to all coming times, as successive generations of inquiring spirits look up to the great names of Plato and Aristotle as loftiest among their guides and forerunners. In the unsurpassed lucidity of diction exhibited by these two masters, we are led into the very foundry of ideas, and can follow the subtle process of new-born thought growing clearer to itself, and shaping language into its close-fitting outward vesture."

THE Queen has intimated through Sir Henry Ponsonby that she will contribute 50*l*. to the guarantee fund in connection with the approaching visit of the British Association to Aberdeen. The fund is now almost completed. We learn that the nomination as President of the British Association at the Birmingham meeting in 1886 has been offered to Sir William Dawson, C.M.G., LL.D., F.R.S., principal of McGill College, Montreal, and that he has telegraphed his intention of accepting the honour.

AN important meeting was held on Monday at Marlborough House, under the presidency of the Prince of Wales, in connection with the Colonial and Indian Exhibition of 1886. The Prince of Wales, in an address of some length, stated the objects of the Exhibition, which is likely to form one of the most attractive and instructive of any recently held at South Kensington. As the Prince stated, the objects for which her Majesty has been pleased to appoint this Commission are, briefly, to organise and carry out an exhibition by which the reproductive resources of our colonies and of the Indian Empire may be brought before the people of Great Britain, and by which also the distant portions of her Majesty's dominions may be enabled to compare the advances made by each other in trade, manufactures, and general material progress. No such opportunity of becoming practically acquainted with the economic condition of our colonies and the Indian Empire has ever been afforded in this country. A guarantee fund of 128,000*l*. has already been secured, though it is not likely that any of this will be required.

THE following are the Royal Institution lecture arrangements after Easter:—Prof. Gamgee, eight lectures on digestion and nutrition, on Tuesdays, April 14 to June 2; Prof. Tyndall, five lectures on natural forces and energies, on Thursdays, April 16 to May 14; Prof. Meymott Tidy, three lectures on poisons in relation to their chemical constitution and to vital functions, on Thursdays, May 21, 28, June 4; Mr. W. Carruthers, four lectures on fir-trees and their allies, in the present and in the past, on Saturdays, April 18 to May 9; Prof. Odling, two lectures on organic septics and antiseptics, on Saturdays, May 16, 23; and Rev. C. Taylor, two lectures on a lately discovered document, possibly of the first century, entitled "The Teaching of the Twelve Apostles," with illustrations from the Talmud. The Friday evening meetings will be resumed on April 17, when Prof. S. P. Langley, of the Alleghany Observatory, Pennsylvania, will give a discourse on sunlight and the earth's atmosphere.

ON March 25 the Sunday Society held a National Conference at St. James's Hall with the authorities and officers of museums, art galleries, and libraries which have been open in the United Kingdom on Sundays. There was a good attendance, those present for the most part being representative men; a large number of ladies were present. Prof. Corfield, the Chairman of the Committee, presided. The chairman having briefly opened the proceedings, official statements respecting the Sunday opening of the following institutions, which are supported by public money, were submitted by different speakers:—National Museum and Exhibition of Pictures at Kew; National Picture Galleries at Hampton Court Palace; National Picture Gallery at Greenwich Hospital; National Gallery, Dublin; National Museum of Science and Art, Dublin; Birmingham Art Gallery and Library; Manchester—six Free Public Libraries; Middlesborough Free Public Library; Newcastle-upon-Tyne Free Public Library; Stockport Museum; Stoke-upon-Trent Free Library and Museum; Wigan Free Public Library. Each of these official statements spoke of satisfactory results as the outcome of Sunday opening, the statements by Mr. Valentine Ball, F.R.S., Director of the Dublin Science and Art Museum; Mr. Caddie, Principal Librarian and Curator of the Library and Museum in Stoke-upon-Trent, and by Major Turner, Chairman of the Stockport Library and Museum, being specially exhaustive and interesting. The Rev. Septimus Hansard, M.A., rector of Bethnal Green, proposed the following resolution:—"That the facts submitted to this Conference respecting those public museums, art galleries, and libraries which have been opened on Sundays in the United Kingdom are most satisfactory, and it is hereby resolved that they be embodied in petitions to be presented to the Lords of the Treasury and the House of Commons, praying that the trustees of the British Museum and the National Gallery may be provided with the money required to enable them to open these institutions on Sunday afternoons." This was seconded by Mr. John Westlake, Q.C., LL.D., and supported by a great many speakers, including Mr. Wyles, of Coventry; Mr. Freak, of the National Boot and Shoe Riveters' Society; Mr. Steele, J.P., of Rochester; Mr. Faulkner, M.A., of Oxford; Mr. R. M. Morrell, Mr. H. Rutherford, and Mr. Mark H. Judge. The resolution was carried unanimously.

MR. THOMAS FLETCHER, of Warrington, gave a useful lecture on "Smokeless Houses and Manufactories" at the Parkes Museum on March 26. In concluding his lecture, Mr. Fletcher said:—"The ground has been cleared by independent experimenters, and I think it may fairly be said that both houses and all manufacturing industries can be profitably carried on absolutely without smoke, and it is simply a question of time as to when this state of things becomes general throughout the world. Some people are afraid that when after a short time the coal supply of England is exhausted, the predicted New Zealander, when he sits on the ruins of Westminster Abbey, will be able to live on the rabbits caught amongst the ruins; but if gaseous fuel is adopted in our houses and flameless regenerative furnaces are used in our manufactories it is probable that the coming New Zealander will have to defer his visit for a length of time which the present generation need not consider; in fact, we shall be able to import our fuel from unexhausted countries, and hold our own against them after our coal is all gone.' The future of gaseous fuel is settled beyond all question on the best of all possible grounds, that it is profitable to use, and users of solid fuel will soon discontinue their present system when they learn their position in the matter."

FROM a letter addressed by the Rev. Edward Reynolds, of Rowland, Limestone County, Alabama, United States, dated September 23, 1884, to the Krakatoa Committee of the Royal Society, we take the following extract:—"Soon after becoming acquainted with the zodiacal light, I began to notice red sunsets. After a few years I noticed that they invariably followed the commencement of the zodiacal light, and continued about the same length of time—that is, about two or three months. I seldom failed to call the attention of my friends and neighbours to these phenomena. Until this last display of the zodiacal light, and its invariable attendants, the red sunrises and sunsets, I have always accounted for the redness by supposing it to be caused by the oblique passage of the sun's rays through his nebular train. But this season I have been obliged to give up that theory, because the redness has continued after the disappearance of the zodiacal light. It is now more than ten months since their commencement, about November 13. They still continue to show no signs of abatement, but rather increase in vividness. Hence, I infer that the immediate cause of the redness is within the atmosphere, rather than in the distant and invisible nebulous train of the sun. We have not this season had a single day nor hour of clear, blue sky, such as is common in ordinary years. We have had plenty of *cloudless* days, but none of the pure blue. There is a yellowish, creamy whiteness, especially far and wide about the sun, even at midday. In looking across a forty-acre lot there is, at all times of the day, a peculiar blueness in the atmosphere, whilst at night not more than a third or half of the stars can be seen. The freer from clouds the heavens are, the more distinctly do the red sunrises and sunsets appear; and so of the other appearances of the atmosphere I have mentioned. During the evenings following November 13 last I was able to see the zodiacal light but a few times, and then very indistinctly. I watched long for an opportunity to show it to my friends and neighbours, but failed to find an evening when it could be seen by unpractised eyes. It has never been so before, since my attention was called to this subject forty-four years ago."

THE following account, we learn from *Science*, of unusual phenomena was received, March 10, at the Hydrographic Office, Washington, from the branch office in San Francisco. The barque *Innerwich*, Capt. Waters, has just arrived at Victoria from Yokohama. At midnight of February 24, in latitude 37° north, longitude 170° 15′ east, the captain was aroused by the mate, and went on deck to find the sky changing to a fiery red. All at once a large mass of fire appeared over the vessel, completely blinding the spectators; and, as it fell into the sea some fifty yards to leeward, it caused a hissing sound, which was heard above the blast, and made the vessel quiver from stem to stern. Hardly had this disappeared, when a lowering mass of white foam was seen rapidly approaching the vessel. The noise from the advancing volume of water is described as deafening. The barque was struck flat aback; but, before there was time to touch a brace, the sails had filled again, and the roaring white sea had passed ahead. To increase the horror of the situation, another "vast sheet of flame" ran down the mizen mast, and "poured in myriads of sparks" from the rigging. The strange redness of the sky remained for twenty minutes. The master, an old and experienced mariner, declares that the awfulness of the sight was beyond description, and considers that the ship had a narrow escape from destruction.

THE United States Bureau of Education have printed and distributed an address, by the Rev. A. D. Mayo, on the subject of education in the South, which, balloon-like, may raise some heavy hearts by its very inflation! He urges the folly of casting upon the ignorant mass of either race the responsibility of educating itself, and he tries to rouse enthusiasm like his own among Southerners who are educated; urging the first call upon local taxes to which education is entitled; the amount of voluntary effort which may be made by both males and females, who appreciate his views and will qualify themselves for teachers; and the small importance of buildings, books, or apparatus, where a school has been commenced from the "soul end," good teacher.

IT is unquestionable now that the new trigonometrical survey which has been made in the Netherlands (especially by the late Mr. Stamkart) for the European Commission since 1864 is not sufficient for the purpose for which it was undertaken, and the second chamber of the "Staten Generaal" has lately voted the money required for doing the work over again. Strange to say, it was the Minister himself who objected to this item, saying that as long as Mr. Stamkart lived, his colleagues (the other Dutch deputies to the European Commission) had made no objection to his work, and consequently he feared that perhaps later it might be said that the survey now proposed would also have to be done over again. Though it is to be regretted that such is the case, we cannot wonder at the Dutch Government objecting to such an expense, after its experience both in the Netherlands and in the Dutch East Indies.

THERE is a curious analogy in China to the English custom of burying suicides at cross-roads, with a stake through their body. The body of the *felo de se* who is so irreverent as to commit self-destruction within the precincts of that portion of Peking in which the Imperial Court is situated, is solemnly brought to some public place, such as a bridge, and there flogged.

THE inaugural address of the President of the Leicester Literary and Philosophical Society on the jubilee of the Society, which has been published separately (Leicester: Clarke and Hodgson) is characterised by a circumstance which is probably unprecedented in the history of societies. The President for the year is Dr. George Shaw, who was the President, and who delivered the first address to the Society fifty years ago; the same President of a society at its formation and at its fiftieth anniversary is a coincidence of peculiar interest. Dr. Shaw was naturally retrospective, for he described the labours of the founders, and the progress which has been made in the half century. The little pamphlet should be of use to all interested in steering young societies through the rocks and shallows which beset all enterprises in the earlier stages of their existence. In the case of the Leicester Society the stages were: (1) the papers were too dry and abstruse, and no one attended—learning was suffocating the infant; (2) they became popular, less philosophical, and more literary, to the detriment of severer study—the infant's constitution was being destroyed by sweets; (3) popular public lecturers began to be employed in an increasing ratio, and their presence was indicative of a want of energy amongst its members. After his biography of the Society, Dr. Shaw discusses the spirit of the present age, and the members of the Leicester Philosophical and Literary Society were to be congratulated if their presidential address fifty years ago were anything like so vigorous, encouraging, and abreast of time as that on their jubilee.

MR. ADAM SEDGWICK has in preparation a new book, to be entitled "The Elements of Animal Biology," which is intended to serve as an introduction to the study of animal morphology and physiology. Messrs. Swan Sonnenschein and Co. are to be the publishers.

DR. BULLER, of Wellington, New Zealand, is preparing for the press a new and enlarged edition of his "History of the Birds of New Zealand." The "history" will comprise a general introduction on the ornithology of New Zealand, a concise diagnosis of each bird in Latin and English, synoptical lists

of the nomenclature, and a popular history and description of all the known species, brought down to the latest date. It will be published in parts, each containing not less than ten coloured plates. The size will be large quarto.

MESSRS. ASHER AND CO. announce as just ready "The Chittagong Hill Tribes," results of a journey made in the year 1882 by Dr. Emil Riebeck, Ph.D., F.R.G.S., translated by Prof. A. H. Keane.

THE Oyster Fishery in the United States employs 53,805 persons, and yields 22,195,370 bushels of oysters, worth 30,438,852 dollars. In France 32,431 persons are engaged in the industry, which produces 43,307*l.*, and in Great Britain 3,000,000*l.* The oyster industry is rapidly passing from the hands of the fishermen into those of oyster culturists, and in the United States is carried on in so reckless a manner that the Government are being urged to interfere in the matter.

WE have received a copy of "Ellis's Irish Education Directory." The part of the book relating to "National Education" has been remodelled so as to make it a complete guide to the National System. The "Irish Educational Guide and Scholastic Directory" has now been incorporated with "Ellis's Irish Education Directory."

AT the last meeting of the Seismological Society of Japan (as reported in the *Japan Weekly Mail*) Prof. Koto read a paper on the "Movement of the Earth's Crust," as these have been observed in Japan. It appears that the south and east coasts are gradually rising, while the north and west coasts are subsiding. This phenomenon is directly connected with the intensity of seismic activity along the eastern seaboard, almost every earthquake felt in the capital cooming from a region extending from north-east to south-east or nearly south, while hardly any originate in the west. Mr. Sekiya described in detail the great earthquake of October 15 last year. It was attended by unusual barometric variations. The thermometer, which averaged 16° C. during the month, rose to 27° immediately before the shock, while the wind blew with a force of 43 kilometres per hour. The shock occurred at 4′ 21″·54 after midnight, and lasted for 5′ 20″, during which time no less than 200 complete vibrations were recorded. During the first second the motion of the earth measured only 2·5 mm., but rose to 13 mm. in the third, and reached its maximum intensity of fully 42 mm. in the fourth second. The shock was then travelling with a velocity of 200-280 mm. in the second. Over a hundred reports were received by the Meteorological Bureau from various parts of the country, from which it appeared that the area affected by the shock was 24,728 square miles. Eighty-six per cent. of the pendulum clocks in Tokio were stopped, and much damage of the kind usual in these shocks was done. Mr. Sekiya states that this earthquake was the severest since February 22, 1880, to which it was remarkably similar in many ways. Both originated somewhere on the east side of the Bay of Yedo, and both affected the same area. In both instances the origin of the shock was in all probability due to the formation of a subterranean fissure.

THE additions to the Zoological Society's Gardens during the past week include a Macaque Monkey (*Macacus cynomolgus*) from India, presented by Miss Pyne Hamilton; a Blaubok (*Cephalophus pygmæus*) from South Africa, presented by Mr. A. Best; a Russ's Weaver-bird (*Quelea russi*) from West Africa, presented by Mr. J. Abrahams; a Long-eared Owl (*Asio otus*), a Common Buzzard (*Buteo vulgaris*), a Common Kestrel (*Tinnunculus alaudarius*), European, presented by Mr. Scott B. Wilson; two Ravens (*Corvus corax*), British, presented respectively by Mr. J. Bradley, jun., and Mr. Gerard Sloper; a Common Lizard (*Lacerta vivipara*), British, presented by Mr. Stanley S. Flower; a Wattled Starling (*Dilophus carunculatus*) from South Africa, purchased; a Common Otter (*Lutra vulgaris*), British, received on approval.

OUR ASTRONOMICAL COLUMN

A STAR WITH LARGE PROPER MOTION.—Dr. Gould notifies the probable existence of very large proper motion in a star of a little below the eighth magnitude, which is No. 1584 of Hour xxiii. in the Cordoba Zone Catalogue; the position for 1875·0 is in R.A. 23h. 58m. 1·85s., Decl. −37° 58′ 18·8″, consequently in the constellation Sculptor. From observations between 1872 and 1884 Dr. Gould infers an annual proper motion of +0·4823s. in right ascension, and −2·4479″ in declination, or 6·2057″ in arc of a great circle in the direction 66° 46′ east of south. This direction, he remarks, differs from that of Lacaille 9352 (which is 15° distant) by 34°. The large proper motion of Lacaille's star, one of 7·5m., was also detected by Dr. Gould; it amounts to 6·9565″; so that it had moved over 14¼ minutes of arc between the year 1752 and the time of the Cordoba observations about the end of 1876.

The annual proper motion of the star, Groombridge 1830, the largest yet remarked in a star north of the equator, is 6·976″, as determined by Argelander in 1843.

WOLF'S COMET.—This comet was observed for position with the 8-inch refractor at the Observatory of Kiel, on March 12, when its distance from the earth was 2·24, and that from the sun 1·94, so that the theoretical intensity of light was just one-tenth of the amount on the night of discovery, September 17. As there is a possibility that the comet may yet be observable with larger instruments during the next period of absence of moonlight, Dr. Lamp has continued his ephemeris from Prof. Krüger's second elements, and a few places are subjoined—

At Berlin Midnight.

	R.A. h. m. s.	Decl. ° ′	Log. Distance from Earth.	Log. Distance from Sun.
April 3	4 19 44	+3 7·3	0·4030	0·3144
5	24 6	3 16·9		
7	28 28	3 26·1	0·4118	0·3193
9	32 49	3 35·0		
11	37 9	3 43·5	0·4204	0·3242
13	41 28	3 51·5		
15	4 45 47	+3 59·2	0·4288	0·3290

THE APRIL METEORS.—The earth will arrive at the descending node of the first comet of 1861, with which the Lyra-meteors of April have been supposed to be connected, on the morning of the 20th inst. In 1861 the comet at this node passed only 214,000 miles within the orbit of the earth, and the elements assign for the radiant R.A. 270·7°, Decl. +33·5°. If the present form of the comet's orbit is due to planetary action at some distant epoch, it is quite as likely that the planet Saturn was the disturbing body, as that it should have been the earth. With the elements of 1861 we find that at a true anomaly of 144° 43′, the comet's distance from the orbit of Saturn is only 0·11, and this point would be reached 2·48 years after perihelion passage. The period of revolution, according to the definitive investigation of Prof. Oppölzer, is 415 years.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, APRIL 5-11

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on April 5

Sun rises, 5h. 28m.; souths, 12h. 2m. 38·2s.; sets, 18h. 38m.; decl. on meridian, 6° 15′ N.: Sidereal Time at Sunset, 7h. 35m.

Moon (at Last Quarter on April 7) rises, 23h. 49m.*; souths, 4h. 19m.; sets, 8h. 48m.; decl. on meridian, 17° 56′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	5 46	13 11	20 36	15 22 N.
Venus	5 23	11 37	17 51	1 58 N.
Mars	5 13	11 22	17 31	1 2 N.
Jupiter	13 41	20 58	4 15*	13 56 N.
Saturn	8 11	16 17	0 23*	21 55 N.

* Indicates that the rising is that of the preceding and the setting that of the following day.

On April 9 at 3h. 48m. there is a near approach of 14 Capricorni to the Moon at 339° from the vertex to right, for inverted image.

Phenomena of Jupiter's Satellites

April	h. m.		April	h. m.	
5 ...	0 13	I. occ. disap.	7 ...	22 45	III. occ. reap.
	3 26	I. ecl. reap.		23 13	III. ecl. disap.
	21 32	I. tr. ing.	8 ...	2 40	III. ecl. reap.
	23 52	I. tr. egr.		21 34	II. occ. disap.
6 ...	18 40	I. occ. disap.	9 ...	2 29	II. ecl. reap.
	21 55	I. ecl. reap.	10 ..	22 13	IV. ecl. disap.
7 ...	2 28	II. tr. ing.	11 ...	2 37	IV. ecl. reap.
	19 7	III. occ. disap.			

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Saturn, April 5.—Outer major axis of outer ring = 39″·8; outer minor axis of outer ring = 18″·1; southern surface visible.

April 8, 2h.—Mercury at greatest elongation from the Sun, 19° East.

GEOGRAPHICAL NOTES

A COMMITTEE of the Geographical Society of Vienna has been appointed to carry out the business arrangements of Prof. Lenz's proposed expedition to Central Africa. It is reckoned that 25,000fl. will be wanted for the expedition. At first it was thought that Herr Lenz might go out as the representative of the united Geographical Societies of Vienna, Berlin, and Munich, but the Society of Berlin has decided to send out an explorer of its own, Dr. Fischer, who will start next month. Dr. Fischer will go for the same purpose as Herr Lenz—that is, to explore the watershed of the Upper Congo, and to find traces of the four missing Europeans. But instead of starting from the west coast, as Dr. Lenz proposes to do, he will proceed from the east coast, going from Zanzibar to Uganda.

THE fifth German Geographical Congress (*Geographentag*) will be held in Hamburg on April 9 to 12. Among the points which will be brought before the Congress are the following: Antarctic investigations by Drs. Neumayer and Ratzel; the importance of the Panama Canal to the trade of the world, and deliberations on a new edition of Dr. Neumayer's "Guide to Scientific Observations on Travel." The afternoons will, as hitherto, be devoted to questions connected with school geography. The exhibition directed by Prof. Pagenstecher promises to be especially interesting and exhaustive. It is intended to exhibit new maps, especially in the domain of hydrography, and all the maps and descriptions of the free town of Hamburg and the adjoining districts. The instruments and apparatus used by travellers will be collected in a single group. Rich public and private collections of African and Central American ethnographical and archæological objects will be exhibited, and in part explained by their owners. An exhibit of the products and articles of trade of the various colonies has been rendered possible by the co-operation of large mercantile firms in Hamburg; and zoological, botanical, and geological collections will be so grouped that the character of single countries and continents will readily strike the eye. Some excursions will also be made, especially one to the marshes of the lower Elbe.

WE have received a reprint of a paper recently read before the Philosophical Society of Glasgow by the Rev. Alexander Williamson, the well-known traveller in North China. In the compass of thirty octavo pages the writer describes rapidly the extent, physical conformation, means of intercommunication (especially the rivers, the enormous importance of which is pointed out with much force), the nature of the soil and its products, meteorology, textile fabrics, oil-producing plants, dyes, the geology, trade routes, the race, population, and finally discusses the future. The portions of the subject to which Dr. Williamson devotes especial attention are precisely those which are wholly passed over, or only hastily glanced at in popular works in China. The section dealing with the geology of China gives some remarkable results, based on the investigations of Pumpelly and Richthofen. These show that under every one of the eighteen provinces of China, each of which is about as large as Great Britain, there are large deposits of coal. In some provinces it underlies the whole country in all descriptions—bituminous, anthracite, cannel, and lignite. The extent of these coal-measures may be gathered from the following statement:—Their total area is about 400,000 square miles in China proper. The coal-field in Hunan alone is greater than the aggregate of the coal-fields of the greatest coal-producing countries in Europe; the Shansi coal-field is one and a half times larger than this aggregate, while in other parts of North China we have coal-fields seven times greater than all the coal districts in Great Britain. And, side by side with all the coal-fields investigated, Mr. Pumpelly found iron ores and ironstone of all descriptions. As regards the important geographical and commercial questions involved in trade-routes with South-Western China, Dr. Williamson is in favour of the route from Moulmein through the Shan States, crossing the Chinese frontier into Yunnan at Ssu-mao (Esmok); but he does not despair of the road by the Irrawaddy to Bahmo, and so by Ja-li to the Yang-tse, more especially as the latter would create a trade for itself—viz. that with Sse-chian. Then there is the ancient route between Central Asia and China, which passes through Hinan, Shensi, and Kansu, the southern branch of which leads through Yarkand, Kashgar, and Khoten to India and Persia, and which was used by caravans prior to the Christian era, while the other branch goes in a north-westerly direction to Bar-Kul, Kuldja, and thence to Russian territory.

MR. STANFORD, of Charing Cross, has published a Catalogue of Maps, and other geographical publications, calculated to be of great service to all who may have occasion to inquire after such things. The catalogue covers seventy-two pages, is carefully classified, beginning with maps of the world; after the title of each map is an account of its special features, its size, number of sheets, scale in miles to an inch, and price, according to method of doing up. The Catalogue, we may say, contains the maps of all the leading publishers in Europe. As Mr. Stanford is now sole agent for the Ordnance Survey Maps, a special section of the Catalogue is devoted to this department, and contains a very useful index map.

MESSRS. W. AND A. K. JOHNSTON have also sent us a copy of their new catalogue of the many geographical and other works published by that well known firm. We have also from the same firm a very excellent wall-map of Egypt, embracing the country down to the south of Lake Victoria Nyanza; it is brought so well up to date as to contain the leading features of Masai Land discovered by Mr. Joseph Thomson's second expedition. Accompanying the map is a useful Handbook of the Geography of Egypt.

THE Arctic ship *Alert*, when returned by the Government of the United States to the Admiralty at Halifax, will be placed at the disposal of the Canadian Government, for the purpose of continuing the exploration in which they are now engaged of the Hudson Bay and Straits.

A COMMITTEE, consisting of members of the Italian Senate and Chamber of Deputies and other influential persons, has been formed at Turin for the purpose of furnishing Sig. Auguste Franzoi with the means of enabling him to carry out his proposal to explore the country between the Abyssinian province of Kaffa and the Lakes of Equatorial Africa.

THE most important paper read before the Paris Society of Commercial Geography at its meeting on the 17th ult. was one by M. Delbuell, the explorer of the northern part of the Malay peninsula. He described his discovery of a large lake, during his survey of the isthmus of Krao, called Tabé-Sab, which is bordered by fertile plains, where elephants and buffaloes abound. The people inhabiting this region have hitherto been unknown; they appear to be mestizos, half Siamese, who call themselves Samsams.

AT the last meeting of the Geographical Society of Marseilles M. Brémond read a detailed account, with itineraries, of his travels in the kingdom of Choa.

THE first number for the current year (Band viii. Heft 1) of the *Geographische Blätter* of the Bremen Geographical Society contains papers on the forest districts of Bavaria, the abodes and wanderings of the Esquimaux of Baffin Land, by Dr. Boas, Schwatka's exploration on the Yukon, New Zealand past and present, the German journey of exploration through South America, and numerous smaller communications.

THE last number (Band xx. Heft 1) of the *Zeitschrift* of the Geographical Society of Berlin contains the following papers:—A description by Dr. von Langegg of Old Cairo, situated about four kilometres to the south-west of the Arab quarter of modern Cairo; an account of the mission station of Otyimbingue in Damaraland, by C. G. Buttner; the first part of a discussion

of the methods and task of ethnology, by "Achelis"; a map of the Congo, with accompanying description, by Herr Richard Kiepert; and a note on the additions and changes made in the Chinese administrative organisation of the Thienshan region. The *Verhandlungen* (Band xii. No. 2) of the same Society contains a criticism by Herr Erman, who has for some years had charge of the historical and geographical departments of the Royal Library at Berlin, of the methods in which the work of compiling a bibliography of the geographical works relating to Germany—a "Bibliotheca geographica Germaniæ"—is being carried out.

At the meeting of the Geographical Society of Paris on March 20, a letter was read from the French Consul at Asuncion in Paraguay, giving details of the expedition sent by the Argentine Government to explore the Pilcomayo, and to ascend to the Bolivian frontier if possible. It has been found that, owing to impassable rapids, the river cannot be utilised as a route between Paraguay and Bolivia. The only practicable route is that by land, the possibility of which was recognised in 1883 by M. Thouar's expedition. M. de Cailland described the Pescadore archipelago in the Formosan channel. The islands have excellent roadsteads, and form the key to Formosa. M. Simonin read a note on the Indian population of the United States; and M. Jules Garnier described his project of an aërial railway for Paris.

A NEW ARRANGEMENT OF THE APPARATUS OF THE ROTATING MIRROR FOR MEASURING THE VELOCITY OF LIGHT[1]

HAVING now been engaged for a number of years in measuring the velocity of light by means of the rotating mirror, I have succeeded in rearranging the apparatus in such a manner as, by means simply of two mirrors, one fixed, the other movable, placed at a distance of a few metres from each other, to obtain, even with a very moderate velocity of rotation, a deviation of the image of a fixed object as large as may be desired in theory and limited in practice only by the intensity of the light and the perfection of the optical apparatus.

To describe in a few words the plan of L. Foucault's celebrated experiment:—The rays issuing from a narrow aperture fall, at a distance of 1 m., on a rotating mirror 14 mm. in diameter, and, on being reflected there, traverse an object-glass placed as near the mirror as possible. This object-glass throws an image of the aperture on a spherical concave mirror having a radius of 4 m. placed at a distance of 4 m. from the rotating mirror. A second mirror, in all respects perfectly corresponding with the first, receives the reflected pencil, which produces a fixed image of the rotating mirror, and transmits a movable image of the aperture to a third mirror, and so on. Foucault's apparatus comprised five similar mirrors. The last, in which a fixed image was formed, reflected on the fourth the light, which retraced its previous course and so came back to the rotating mirror, which again in turn transmitted it deviated in respect of its rotation by an angle twice as large as that at which it had turned when performing the double passage of the mirrors, *i.e.* twice 20 m. The velocity of rotation being 400 revolutions per second, Foucault obtained a deviation of 7 mm.

One of the objections taken to Foucault's experiment and the values he deduced from it respecting the velocity of light, is the smallness of that deviation. It is known how he ingeniously cleared the difficulty by substituting for the measurement of the deviation that of the distance of the aperture from the rotating mirror producing a determined deviation. He did not, however, disguise the fact that the advantage of this substitution is perhaps more specious than real, and he brought forward the plan of an apparatus composed of a series of objectives and of a concave mirror, by means of which the passage of the light might be extended to several hundreds of metres. He had even selected, at the Observatory, the place where his new experiments might be carried out.

I have to confess that, in endeavouring to take advantage of Foucault's scheme, whether by means of object-glass or of mirrors, I struck on such difficulties as caused me to desist from the prosecution of my researches by either of the methods indicated.

In the United States in 1879 Mr. Michelson put in operation the experiment of the rotating mirror at great distances, but under an arrangement which brings the experiment much nearer to the celebrated one of MM. Fizeau and Breguet than that of Foucault. The aperture from which the light issues was placed at a distance of about 30 English feet (9·15 m.) from the rotating mirror, the diameter of which amounted to 1¼ inches (3·2 cm.). A simple non-achromatic lens, 7 inches (17·8 cm.) in diameter, and having a focus of 150 feet (45·75 m.) was placed in such a manner as to throw an image of the aperture, seen by reflection in the rotating mirror, on the surface of a plain mirror, 7 inches in diameter, placed normally to the line passing through the centres of the two mirrors and the lens, at a distance of 1986·23 feet (605·80 m.) from the rotating mirror. The pencil then returns on itself, and gives an image of the aperture coinciding with it, point for point, when the mirror is fixed, deviated as soon as it rotates. The lineal displacement of the image during a rotation of 258 revolutions per second amounted to 114·15 mm. The advantage, however, of such a large displacement seems to be counterbalanced by the inferior quality of the image. A lens 7 inches in diameter, and with a focus of 150 feet will, even under the best conditions, necessarily give an image bounded by very large fringes of diffraction, which atmospheric agitations transform into a luminous blot so ill-defined that, as Mr. Michelson himself confesses, it is impossible to study the effect of the parallax due to the defect of coincidence of the plane of the image with that of the lines of the micrometer; in other words, there is no defined focus.

In all my experiments, therefore, it has been my aim to maintain the perfect accuracy of optical effects, such as had been achieved by Foucault, believing that it is of greater advantage to measure even the small deviations of a perfect image than the exaggerated displacement of a blot of light. I have consequently sought to amplify the deviations of Foucault without increasing the distance to be traversed by the light, and without having recourse to great velocities of rotation on the part of the mirror.

I call to mind, by the way, that Bessel noted, as a means of increasing the deviation, the return of the deviated ray on the rotating mirror. This method, which has never yet been applied, might be utilised by means of a series of little plain mirrors placed in couples on one side and the other of the rotating mirror, in such a way as to transmit the pencil alternatively on one and the other of the two parallel faces of the rotating mirror. With each reflection the deviation increases by a quantity equal to its primitive value.[1] But this process would greatly complicate the measurement of the path traversed by the light. The advantage contemplated by it may, besides, be secured by a method much more elegant and simple.

The apparatus I bring under the notice of the Academy consists purely of two mirrors, one fixed, having a diameter of 0·20 m., the other movable, 0·05 m. in diameter, the two placed at a distance of 5 m. from each other. Both are concave and spherical, and have the same radius of curvature, 5 m. The source of light is a narrow aperture cut in the silver, in the centre of the large mirror. The pencil emanating from it and entirely covering the rotating mirror is reflected by the latter, and returns to form on the surface of the fixed mirror a movable image of the aperture and of the same size. In each of its positions this movable image becomes a source of light; the rays return to the movable mirror, which concentrates them anew into a fixed image: this is the image of Foucault, which coincides with the aperture when the rotation is very slow, which is deviated in respect of the rotation when the latter is a little rapid. Suppose the velocity of the rotating mirror to be such that the lineal deviation is equal to the breadth itself of the aperture, the image will then come to be formed on the fixed mirror, rim to rim with the aperture itself. There it falls on the reflecting surface of the silver, becomes then a source of light exactly similar to the first, producing a second image deviated by the same quantity. The latter in its turn acts like the first, in such a manner that, if one could look on the surface of the fixed mirror, one would there be able to see, issuing from the aperture itself, an indefinite series of identical images placed rim to rim and indistinguishable from each other, except in respect of their regularly increasing brightness. If the velocity of rotation is increased, all these images will be found to separate from each other and form on the fixed mirror a series of equal luminous lines, separated by equal intervals from each other, and

[1] Paper, by M. C. Wolf, in the *Comptes Rendus* for February 9.

[1] These plain mirrors, disposed in couples, might also be used to collect and transmit in one constant direction the light scattered in all directions by the rotating mirror. By this means the advantage would be obtained of observing the doubled deviation of a much more brilliant image.

which will continue increasing their distance from each other, proportionately with the increase of the velocity. If one succeeds in determining micrometrically the distance of one of these lines from the original aperture, he will measure no longer the single deviation of Foucault, but as high a multiple of that deviation as may be desired. The distance of my two mirrors from each other being 5 m., and the velocity of the rotation of the mirror only 200 revolutions per second, the deviation will be five-eighths of that obtained by Foucault—*i.e.* five-eighths of 0·7 mm., or nearly 0·44 mm. The tenth image will consequently be at 4·4 mm. from the aperture.

To assure myself, above everything, of the existence of these multiple images, I employed Foucault's mode of observation, and placed before the luminous aperture, at a little distance from the fixed mirror, a plate of glass with parallel faces, inclined at an angle of 45° to the direction of the axis of the mirror. By this means there is thrown back laterally a portion sufficiently faint, it is true, but still a portion, of each of the deviated pencils which one receives in a microscope. There will then be seen, so soon as the velocity of rotation is great enough to give a continuous image, appearing on the rim of the image of the aperture a second, less distinct image, next a third at the rim of the second, increasing in breadth in proportion as the first is more and more deviated, and ending by separating from one another. With the electric light generated by a small gas-machine of half-horse power, or with the wan sun of these late days, I have managed to see as many as three images and catch a glimpse of the fourth. The actual result very well corresponded with my anticipations. What remains to be done is to improve the method of observation and increase the quantity of light.[1]

Suppose the tenth image is sufficiently intense to be observed, I cut away the silver of the mirror from a little rectangle with rims parallel to those of the aperture. The tenth image will come to be formed in this rectangle, all the following images will be suppressed, and the deviated pencil traversing the glass of the mirror, the posterior face of which is plain and polished, will be received behind on a prism of total reflection, which will transmit it into the micrometric microscope. The distance of the rim of the image from the rim of the rectangle will be measured; then, by an independent operation, the distance of this rim from that of the aperture; the sum of the two will give the line of magnitude of the deviation. It remains to ascertain the order m of this deviation. For this purpose the rotation of the mirror will be accelerated till the image of the order $m - 1$ comes to be substituted for that which was observed. Let n and n' represent the numbers of revolutions of the mirror per second, δ and δ' the lineal values of the simple corresponding deviations, then

$$\delta = kn, \qquad \delta' = kn' \qquad \text{and } m\delta = (m-1)\delta',$$

thence

$$mn = (m-1)n'.$$

whence

$$m = \frac{n'}{n' - n}.$$

The number of revolutions is measured electrically by the methods M. Cornu has so carefully discussed in his work on the velocity of light; I need not dwell on it. Finally, the measurement of the passage of the light is easily got at; it is that of the distance from each other of the centres of the surfaces of the two mirrors.

In order to observe a deviation of a rather high order, all that is needed is a sufficiency of light. Now, in this case, I manage to augment considerably the proportions of utilised light. In the first place the rotating mirror may be made to reflect on its two faces, care being only taken that both have exactly the same radius of curvature. In the second place, having suppressed every object-glass, I am able to utilise the pencil reflected by the rotating mirror throughout the whole space in which it gives a good image of the aperture, and this space is considerable, because the astigmatism resulting from the obliquity does not sensibly affect the rectilineal form of this image. It is, next, possible to tack on to the mirror of 0·20 m., of which I have spoken, a series of other identical mirrors placed at the same distance in the plane of rotation of the pencil. The condition of identity of the radius of curvature is, besides, much less rigorous for these mirrors than in the case of the two faces of the rotating mirror. It is, however, always indispensable that the movable image given by this latter is reflected exactly on to the surface of each of the fixed mirrors.

I have also to remark that it is necessary that the lineal distance of the image observed from the aperture is large enough to allow the observation to be made. For in the thickness of the glass of the mirror and on its two surfaces there will inevitably arise a diffusion, as also reflections of the incident light, to embarrass and even frustrate the exact vision of the deviated image when it is too near the aperture. I have just shown that the actual apparatus ought, under good conditions, to show an image of the sixteenth order, perhaps even one as high as the twentieth—that is to say, at 8·8 m. from the aperture. It would be useful, however, to have recourse to an apparatus of more considerable proportions.

If 20 m. is taken for the radius of curvature of the mirrors and for the length of the simple passage of the light, the movable mirror ought to have a diameter of 0·20 m. Let there be impressed on it a velocity of rotation of only fifty revolutions per second, the deviation calculated according to the experiment of Foucault will be:—

$$0·7 \text{ mm.} \times \frac{40}{40} \times \frac{20}{1} \times \frac{50}{400} = 1·75 \text{ mm.}$$

The displacement of the twentieth image will then be 35 mm., which, measured to the hundredth of a millimetre, will give an approximation of $\frac{1}{3500}$. Now I do not think it impossible to turn a mirror of 0·20 m. as many as fifty revolutions per second without causing deformation of its surfaces. The turbines and the movable pieces of the dynamo-electric machines of the present day frequently attain a similar velocity.

It is my duty to make known to the Academy that the fund necessary for my first and long experiments were generously supplied to me by M. de Romilly, to whom I am happy to make this public testimony of my gratitude.

[1] The quantity of light utilised by this mode of observation on a glass is hardly the tenth of the actual quantity. The ratio of the geometrically decreasing progression representing the intensities of the successive images being 0·656, allowing 0·90 for the reflecting power of the silver, the brightness of the third image seen by reflection from a plate of glass is inferior to that of the eighth image seen directly. The reflecting power of new silver being 0·96, it would be possible by its means to attain to the sixteenth image.

ACCIDENTAL EXPLOSIONS PRODUCED BY NON-EXPLOSIVE LIQUIDS[1]

III.

THE only real danger which may attend the use of the little sponge lamps arises from accidental spilling of spirit used for filling them in the neighbourhood of a flame, or from carrying out the operation of filling in the vicinity of a light. Indeed, such casualties as have been attendant upon the use of petroleum-spirit as an illuminant have been mainly connected with the keeping and handling of the supplies of this very volatile liquid, and are largely attributable to want of caution or to forgetfulness. The salutary regulation prescribed by law, that vessels containing the spirit shall bear a conspicuous label indicating its dangerous character, has undoubtedly operated very beneficially in diminishing the frequency of accidents with it, by constantly admonishing to caution. It is a matter for much surprise and regret that the manufacturers of a class of miners' safety lamps, consisting of modifications of well-known types, with the ordinary oil lamp replaced by the sponge lamp, in which petroleum-spirit is burned, should have allowed trade interests to induce them to mislead those who use these lamps with regard to the nature of the illuminant supplied with them, by devising a name for it which gives a false indication of its nature, being designed to create the belief that it is an article of special manufacture, allied in character to a comparatively very safe oil largely used in miners' lamps, while in reality it is a well-known article of commerce, the safe storage and use of which demand special precautions and vigilance.

The lecturer took occasion to point out here, ten years ago, that a large proportion of the accidents arising out of the employment of petroleum- or paraffin-lamps were not actually due to the occurrence of explosions. Thus the incautious carrying of a lamp, whereby the liquid is brought into contact with the warm portion of the lamp close to the burner, may give rise to a liberation of vapour which, in escaping from the lamp, may be

[1] Address delivered at the Royal Institution of Great Britain, Friday, March 13, 1885, by Sir Frederick Abel, C.B., D.C.L., F.R.S., M.R.I. Continued from p. 496.

ignited, causing an outburst of flame which may alarm a nervous person and cause the dropping or overturning of the lamp. The accident which occurred in some apartments in Hampton Court Palace, in December, 1882, and gave rise to a somewhat alarming fire, appeared almost beyond doubt to have originated from the employment by a domestic servant of a contrivance in which petroleum spirit was used for heating water; but, as petroleum-lamps were used in the particular residence where the fire actually occurred, public correspondence ensued regarding the dangers attending the use of such lamps, although all which were known to have been on the premises were forthcoming after the fire and found to be intact. There was, at any rate, no evidence whatever adduced in support of an assumption that the casualty was due to the explosion of a lamp, and other instances might be quoted in which the breaking out of a fire, or the destruction of or injury to life, which had evidently been caused by upsetting or allowing to fall a petroleum lamp, has been erroneously ascribed to an explosion.

There are, however, numerous casualties which have been unquestionably caused by the occurrence of explosions in lamps, and which have in many cases been followed by the ignition of the oil, and the consequent loss of life or serious injury to those in the immediate vicinity of the accident. Careful inquiries have of late been instituted into casualties of this kind, and in many instances the explosions have been distinctly traceable to some immediate cause. In the great majority of cases they occur some considerable time after the lamp was first kindled, and when the supply of oil remaining in the reservoir has been but small. Occasional examples of the reverse are, however, met with. Thus, last spring, a man and his young son were sitting at a table reading, his wife being also close at hand, when a paraffin lamp, which had just been lighted, exploded, and the room was at once set on fire by the burning oil which escaped. The husband and wife fled from the room, both being slightly injured, but the child was unable to escape from the flame, and was burned to death. The oil used in the lamp was of a well-known brand, having a flashing point ranging from 73° to 86° F., and assuming that the recently lighted lamp had been filled with oil, and was untouched at the time of the explosion, no satisfactory explanation can be given of the accident, unless, perhaps, the reservoir had been so completely filled with oil, that the expansion of the liquid, on its becoming slightly warm, exerted sufficient force to determine the fracture of the glass at some part where a flaw or crack existed.

A lamp accident which occurred last July at Barnsbury, causing the death of a woman and her husband, appears, on the other hand, distinctly traceable to the production of an explosion in the reservoir of the lamp. The latter was stated to have been alight but a short time, when, the husband being already in bed, the wife, in her night-dress, attempted to blow out the flame of the lamp; the man heard a report, and, looking towards the lamp, saw his wife in flames. He proceeded at once to her rescue, and was severely burned in extinguishing the flames in which she was enveloped. The woman died in a few hours, and the man succumbed three days later to the injuries received. There being no witness to the accident, there is no evidence against the supposition that, on the occurrence of a slight explosion in the reservoir in the lamp, the woman, having hold of it when attempting to blow it out, may have upset it, or tilted it so as to cause the oil to flow out and become inflamed. The lamp may have become fractured by the explosion; but whenever such a result has been produced, the lamp had always been burning some time, so that there was considerable air-space which could be filled by an explosive atmosphere, whereas, in this case, the evidence appears positive as to the lamp having been full of oil when lighted.

In another fatal case of a lamp explosion in the same month, at Mile End, the accident was also caused by the attempt on the part of a woman to blow out the lamp before going to bed. In this case the lamp had been burning for three hours; the husband of the sufferer was in bed asleep in the room at the time, and, the woman being unable to give any account of the occurrence, the only information elucidating it was furnished by the daughter, to the effect that the lamp had been burning for three hours, and that it was the habit of her mother to extinguish the lamp by first lowering the wick and then blowing down the chimney.

Another fatal accident, caused by the explosion of a lamp, took place at Camberwell last January, and was brought about, as in the two preceding cases, by attempts to extinguish the lamp by blowing down the chimney. The husband and two sons of the sufferer were witnesses of this accident; the lamp had been burning for six or seven hours, when the woman took it in her hand, and having partially turned it down, proceeded to blow down the chimney; an explosion at once occurred, the glass reservoir was broken, and the inflamed oil flowed upon her dress, burning her most severely.

A lamp explosion which occurred last December in a van used as a bedroom by an itinerant showman, at the so-called World's Fair held at the Agricultural Hall, Islington, and which caused the death of an infant, was of a somewhat different character to the foregoing. The lamp, which was of the duplex-form and was attached to a bracket, had been alight for some hours, when a woman went, from a neighbouring van used as the dwelling room, to extinguish it. She observed that while the lamp, or wick, was only burning faintly, the oil in the reservoir was alight. She placed her apron over the top of the chimney to extinguish the lamp, when it at once appeared to explode, and the burning oil set the interior of the van on fire. The woman ran out for help, and a lad, protecting his head with his coat, rushed in and brought out the infant which was lying upon the bed, and which died from injuries received. The oil used in the lamp was believed to be of high flashing point, being obtained by the retailer who supplied it, from a firm dealing in a Scotch shale oil manufactured by the Walkinshaw Company (known as the "electric light" brand). A sample of the oil, as supplied by the wholesale dealers, had a flashing point of 114° F., but a portion of the oil actually purchased by the owner of the lamp had a flashing-point of only 63° F., and evidently consisted of a mixture of the heavy oil and of benzoline. The oil in question would naturally become exhausted of the volatile spirit after the lamp had burned for some time, and the flame would then have burned low in consequence of the heavy character of the residual oil; the lamp and its contents would have thus become highly heated, and some accidental disturbance of the surrounding air must have caused vapour generated from the heated oil and contained in the air-space of the reservoir, to become inflamed, the oil itself being thereby ignited. By placing her apron hastily upon the top of the chimney, the woman forced air into the reservoir, and thus either caused a slight explosion to take place or determined the breaking of the glass by the sudden change of temperature. A lamp explosion, apparently due to the same cause, occurred quite recently in the cabin of a small steam-launch on the Medway, near Chatham.

Several cases of undoubted lamp explosions, fortunately unattended by serious consequences, have come to the lecturer's knowledge as having occurred in the billiard-rooms of barracks where petroleum or paraffin oil was employed as an illuminant. These lamps are fixed over the billiard-tables, and generally speaking the rooms have top- or sky-lights. In every instance the lamp had been burning for several hours, and had probably become more or less heated, especially as shades of sheet tin were placed over them as reflectors. In each case a portion of the glass reservoir was blown out by the explosion, and the oil, becoming ignited, burnt portions of the table on which it fell.

A careful investigation of accidents of which the foregoing are illustrations,[1] together with a critical examination of the construction of various lamps, and the results of many experiments have, up to the present time, led the lecturer and Mr. Redwood to arrive at several definite conclusions with respect to the immediate causes of lamp-explosions and to certain circumstances which may tend to favour the production of such explosions.

If the lamp of which the reservoir is only partly full of oil be carried, or rapidly moved from one place to another, so as to agitate the liquid, a mixture of vapour and air may make its escape from the lamp in close vicinity to the flame, and, by becoming ignited, determine the explosion of the mixture existing in the reservoir. This escape may occur through the burner itself, if the wick does not fit the holder properly, or through openings which exist in some lamps in the metal work, close to the burner, of sufficient size to allow flame to pass them readily. A sudden cooling of the lamp, by its exposure to a draught or by its being blown upon, may give rise to an inrush of air, thereby increasing the explosive properties of the mixture of vapour with a little air contained in the reservoir, and the flame of the lamp may at the same time be drawn or forced into the

[1] Mr. Alfred Spencer, of the Metropolitan Board of Works, has obligingly furnished me with the official details of several of the accidents above referred to.—F. A. A.

air-space filled with that mixture, especially if the flame has been turned down, as the latter is thereby brought nearer to the reservoir. The sudden cooling of the glass, if it had become heated by the burning of the lamp, may also cause it to crack if it is not well annealed, and this cracking, or fracture, which may allow the oil to escape, may convey the idea that an explosion has taken place. If the evidently common practice is resorted to of blowing down the chimney with a view to extinguish the lamp, the effects above indicated as producible by a sudden cooling may be combined with the sudden forcing of the flame into the air-space, and an explosion is thus pretty certain to ensue, especially if that air-space is considerable. If the flashing-point of the oil used be below the minimum (73° Abel) fixed by law, and even if it be about that point or a little above it, vapour will be given off comparatively freely if the oil in the lamp be agitated, by carrying the latter or moving it carelessly; the escape of a mixture of vapour with a little air from the lamp, and its ignition, will take place more readily, but on the other hand it will probably be feebly explosive, because the air will have been expelled in great measure by the generation of petroleum vapour. If the flashing-point of the oil be high, the vapour will be less readily or copiously produced, under the conditions above indicated, but, as a natural consequence, the mixture of vapour and air existing in the lamp may be more violently explosive, because the proportion of the former to the latter is likely to be lower and nearer that demanded for the production of a powerfully explosive mixture. If the quantity of oil in the lamp reservoir be but small, and the air-space consequently large, the ignition of an explosive mixture produced within the lamp will obviously exert more violent effects than if there be only space for a small quantity of vapour and air, because of the lamp being comparatively full. If the wick be lowered very much, or if for some other reason the flame becomes very low, so that it is burning beneath the metal work which surrounds and projects over the wick-holder, the lamp will become much heated at those parts, and the tendency to the production of an explosive mixture within the space of the lamp will be increased, while, at the same time, heat will be transmitted to the glass, and it will be correspondingly more susceptible to the effects described as being exerted by its sudden exposure to a draught. Experiments have demonstrated that a lamp containing an oil of high flashing point is more liable to become heated than a comparatively light and volatile oil, in consequence of the much higher temperature developed by the combustion, and of the comparative slowness with which the heavy oil is conveyed by the wick to the flame. It therefore follows that safety in the use of mineral oil lamps is not to be secured simply by the employment of oils of very high flashing point (or low volatility), and that the use of very heavy oils may even give rise to dangers which are small, if not entirely absent, with oils of comparatively low flashing points. The occurrence of such an accident as that in the training-ship *Goliath*, already referred to, which was brought about by a boy letting fall a lamp which had been alight all night, and which was so hot that he could no longer hold it, appears to be primarily ascribable to the use of an oil of very high flashing point; and the accident at the Agricultural Hall furnished another illustration of the kind of danger attending the use of such an oil.

The character of the wick very materially affects not only the burning quality of the lamp, but also its safety. A loosely plaited wick of long staple cotton draws up the oil to the flame regularly and freely, and so long as the oil be not very heavy or of very high flashing point, and therefore difficultly volatisable or convertible into vapour (by so-called destructive distillation), the flame will continue to burn brightly and uniformly, with but little charring effect upon the wick—that is to say, the extremity of the latter will only be darkened and eventually charred to a distance of much less than a quarter of an inch downwards, and it will not be until the partial exhaustion of the oil-supply diminishes the size of the flame and induces the user to raise the wick, that the latter will become more considerably charred. But, if the wick be very tightly plaited, and made, as is not unfrequently the case, of a short staple cotton of inferior capillary power, the oil will be less copiously drawn up to the flame; as a consequence, the length of exposed wick will be increased by the user of the lamp, and as the evaporation of the oil will take place more slowly from each portion of the wick which furnishes the flame, the heat to which the cotton is exposed will be greater, and the charring, which is fatal to the proper feeding of the flame by destroying the porosity of the end of the wick, will take place more rapidly and to a much greater extent.

Even with wicks of the higher qualities, considerable differences exist in the rapidity with which the oil is raised to the flame. In Mr. Redwood's experiments, conducted with a specimen of English wick of good quality and with a very superior American wick, of corresponding dimensions, the quantity of oil siphoned over by the latter in a given time, was from 35 to 47 per cent. greater (according to the nature of oil experimented with) than that carried over by the English wick.

If the wick be at all damp when taken into use, its power of conveying the oil to the flame will be decidedly diminished, the capillaries of the fibre being more or less filled with moisture, and similarly, if the oil accidentally contain any water, the latter, passing into the wick, will interfere with the proper feeding of the flame. As the oil is very thoroughly filtered or strained during its transmission through the body of the wick to the flame, it is obvious that any impurities suspended in the liquid will be deposited within the wick and will gradually diminish its porosity. For this reason the same wick should not be used for a great length of time, and it is decidedly objectionable to use a much greater length of wick than is necessary to reach to the bottom of the reservoir, and to continue its use until it has become too greatly shortened by successive trimmings. On the other hand, the wick should always be of sufficient length to be immersed to a considerable distance in the oil. It is evident that the copious supply of oil to the flame will become reduced as the column of liquid which covers the wick in the reservoir becomes reduced in height; hence the supply of oil in the lamp should never be allowed to get very low, not only because it is undesirable to have a large air-space which may be filled with vapour and air, but also because the burning of the lamp is injuriously affected thereby.

Some lamps of patterns first constructed in the United States are provided with what may be called a feeding wick, in addition to the wick or wicks which furnish the flame. This wick is generally simply suspended from the lower surface of the burner, and reaches nearly to the bottom of the reservoir, being so placed that it hangs against one flat side of the regular wick, and thus aids considerably the copious and uniform absorption of oil by the latter. In certain lamps of recent construction the reservoir which contains the main supply of oil is so arranged (upon the principle of the old study- or Queen's oil-lamp) that it regularly maintains at a uniform level the supply of oil, which surrounds the wick in a small central reservoir or cylinder, separated from the main reservoir (excepting as regards a small channel of communication) by an air-space, which presents the additional advantage of preventing the transmission of heat to the oil vessel. This kind of lamp is constructed entirely of metal; this is the case now with a very large proportion of the lamps in use, and unquestionably adds greatly to the safety of lamps, which, if constructed of glass or porcelain, are always liable to accidental fracture, quite apart from the question of possible explosion.

It has been proved experimentally that if the reservoir of a burning lamp be warmed, so as to favour the emission of vapour into the space above the oil, and a small opening in the top of the reservoir be then uncovered, air will be drawn into the latter and form an explosive mixture with the vapour, which, escaping from the lamp close to the wick-holder, will be fired, and produce an explosion in the lamp. It is an interesting illustration of the very imperfect appreciation, by some lamp-designers, of the conditions which, in the construction of a lamp, secure safety or determine danger, that the reservoirs of some petroleum-lamps are actually furnished with an opening in the upper surface, which is closed with a more or less badly-fitting metal cap, and is intended to be used for filling the lamp with oil. Independently of the great element of danger which this fitting presents, in consequence of the obvious temptation to the users to replenish the reservoir while the lamp is actually burning, it is very likely sooner or later to be the means of admitting to the reservoir, in the manner above indicated, the supply of air necessary to determine the explosion of vapour therein existing.

Another source of danger introduced in the construction of lamps which should be sufficiently obvious, and to which reference was made when first discussing the causes of lamp explosions, consists in the provision in many lamps, of openings of considerable size close to the burner, apparently with the object of affording a passage for the air or vapour in the reservoir, which may expand as the lamp becomes somewhat warm. Other

devices with the same object in view, consisting of small channels or shafts brought up from the top of the reservoir to the seat of the lamp flame, are adopted in some American lamps. If these openings or channels were protected, in accordance with the well-known principles which govern the construction of miners' safety lamps, so as to preclude the possibility of flame passing them, they would obviously be unobjectionable, and indeed in one or two instances of modern lamps the openings which have been provided for the escape of expanding air or vapour are of such dimensions that flame could not pass. A simple arrangement which would effect the desired object with perfect safety, and would at the same time protect the lamp wicks from deterioration by the grosser impurities sometimes contained in portions of a supply of oil, is to attach to the bottom of the burner a cylinder of wire gauze of the requisite fineness (twenty-eight meshes to the inch) which would contain the wicks, and would allow the passage of air or vapour through it towards the burner, while it would effectually prevent the transmission of fire from the lamp-flame to the air-space of the reservoir.

Some of the more prominent points elicited by the inquiry in progress, as to the causes of explosions in petroleum lamps, and the conditions which regulate their efficiency and safety, having now been noticed, it remains to offer a few simple suggestions, attention to which cannot but serve to reduce the risks of accident which attend the use of petroleum and paraffin oil :—

1. It is desirable that the reservoir of the lamp should be of metal. It should have no opening or feeding place in the reservoir, nor should there be any opening or channel of communication to the reservoir at or near the burner, unless protected by fine wire gauze, or packed with wire, or unless it is of a diameter not exceeding 0·04 inch.

2. The wick used should be of soft texture and loosely plaited ; it should fill the entire space of the wick-holder, and should not be so broad as to be compressed within the latter ; it should always be thoroughly dried before the fire, when required for use. The fresh wick or wicks should be but little longer than sufficient to reach to the bottom of the reservoir, and should never be immersed to a less depth than about one-third the total depth of the reservoir.

3. The reservoir or lamp should always be almost filled before use.

4. If it be desired to lower the flame of the lamp for a time, this should be carefully done, so as not to lower it beneath the metal work deeper than is absolutely necessary ; but it should be borne in mind that even then the combustion of the oil will be imperfect, and that vapour of unconsumed petroleum will escape, and render the lamp very unpleasant in a room.

5. When the lamp is to be extinguished, and is not provided with an extinguishing arrangement (of which many excellent forms are now applied to lamps) the flame should be lowered until there is only a flicker ; the mouth should then be brought to a level with the top of the chimney, and a sharp puff of breath should be projected *across* the opening. The lamp should remain on a firm support when it is being extinguished.

The lecturer hopes that, pending the more thorough treatment of this subject by Mr. Redwood and himself when these investigations are completed, the points dealt with in this discourse which relate to accidents with petroleum lamps may, on the one hand, tend to dispel groundless alarm as to the dangerous nature of petroleum and paraffin oil as illuminants, and may, on the other hand, serve to convey some useful information respecting the causes which lead to accidents with lamps and the readiness with which they may be avoided.

DR. KLEIN ON CHOLERA

AT a recent meeting of the Abernethian Society of St. Bartholomew's Hospital, Dr. Klein briefly reviewed the accepted theories as to the ætiology of cholera, and stated the views concerning it which he had been led to adopt since his visit to India. His address is of importance as embodying the conclusions of the Indian Commission of Inquiry into this disease. Two main theories are held with regard to the cholera —the one, which is supported by a large section of the Indian medical staff, being that cholera is non-infectious and non-communicable ; the other, which is upheld by European authorities, being that it is both infectious and communicable. In support of the former theory may be quoted the numerous cases of sporadic cholera which occur, and the fact that when troops are attacked in a military cantonment and are at once marched out into camp, no new cases occur other than those which are already incubating. Lastly, in many places in India, in spite of all conditions favourable to a spread of cholera by the evacuations, it is rare for any but sporadic cases to occur. In support of its communicability and infectiousness it is unquestionable that when an outbreak of cholera has occurred, it has in most instances been introduced from a district where cholera was rife, as instanced by the late outbreak at Marseilles, which was shown to have been introduced from Egypt. Some have maintained that it may be conveyed by winds ; against this may be adduced the fact that epidemics have occurred in Malta without any occurring at the same time in Gozo. Now, Gozo is nearer to Egypt than Malta, and yet no epidemic at Malta has ever been preceded by an epidemic at Gozo. The upholders of the theory of infectiveness are divided into two schools—the contagionists, who consider that the disease is directly communicable from the sick to the healthy, and that the virus is contained in the discharges from the alimentary canal ; and the localists, who believe that the evacuations contain a germ which is capable of elaborating the virus under suitable conditions of climate and soil. Against the contagionists' view must be considered especially these facts—that it is very rare for attendants to be attacked early, and that they only succumb at a late period of the epidemic ; and that cholera patients are treated in the general wards of a large hospital in Calcutta, and yet no cases of contagion have occurred. Dr. Koch, in studying this disease, found that the lower parts of the small intestine of patients who died from cholera swarmed with peculiar bacilli (comma bacilli), which passed out with the evacuations, and which he considered were capable of manufacturing the cholera virus when introduced into the small intestine of an unhealthy patient. He also believes that this bacillus is destroyed by the acid secretion of the stomach of a healthy person, and, further, that this bacillus is destroyed by drying ; and hence that this disease could not be propagated by soiled linen after this had been dried. The German Commission believes these bacilli to be the cause of the disease. Dr. Klein, by a series of experiments, has proved that these comma bacilli are not destroyed by an acid solution of the same strength as that of the gastric juice ; but that, on the contrary, they thrive after having been immersed in such a solution. Further, that though these bacilli, in common with all germs (except spores of bacilli), are destroyed by thorough and scientific drying, still soiled linen never becomes thoroughly dry. Klein thinks that even the location of these bacilli in the lower part of the small intestine should of itself suggest suspicion, inasmuch as bacilli and micrococci in great numbers are contained in it even in health, and the more because this locality is not the exclusive seat of the disease. More conclusive evidence, however, was collected by him in India. For instance, three of the houses situate in a certain street in Calcutta contained in all eight cases of cholera. Leading out of the street was a narrow lane to a large water-tank, around which was built a squalid rookery. The water of this tank was used in the rookery for all purposes, and contained the comma-bacilli. Now, the houses in the street were not supplied with water from the tank, and yet eight cases of cholera occurred in the square, while none were found in the rookery, which was inhabited by about 200 families. The English Cholera Commission has also found a bacillus apparently similar with the cholera-bacillus in the intestines of children and adults suffering from diarrhœa. Dr. Lewis, of Netley, has found the same in the saliva of healthy persons. With regard to the evacuations containing the virus, Dr. Klein found that in India many of the public-built wells were contaminated by sewage, and that the water, though nominally not used for drinking purposes, for expediency was generally so used, and especially at night time. Again, at Benares a large sewer opens into the Ganges at a spot where the pilgrims and natives perform their religious ablutions, these including especially the washing out of the mouth with the river water. In spite of this only sporadic cases of cholera occur. Dr. Klein has been led to the conclusion with regard to the cholera—that Koch's bacillus cannot be the cholera germ.

SCIENTIFIC SERIALS

American Journal of Science, March.—Prof. Marsh's monograph on the Dinocerata, by L. P. B. This valuable contribution to American palæontology forms a sequel to the author's

work on the Odontornithes, or birds with teeth, and contains a full account of the peculiar order of mammals discovered by him during the last fifteen years in the early tertiary formations of the great central plateau in Wyoming. The old lacustrine basin of this region, where alone the remains of Dinocerata have hitherto been found, have already yielded parts of over 200 individuals, which are now grouped in three genera: Dinoceras, Marsh; Tinoceras, Marsh; and Uintatherium, Leidy. The last-named appears to be the most primitive type, and Tinoceras the most specialised, Dinoceras being intermediate. Of species the number cannot yet be determined, but thirty more or less distinct forms have already been recognised. In stature and movements it appears to have resembled the elephant as much as any other known type, differing from it especially in the shape of the skull, remarkably small brain, longer neck, and more bent fore limbs. It was by far the largest of all known Eocene animals. The paper is enriched with numerous illustrations, and with a map showing the region of Dinoceras beds.—On Taconic rocks and stratigraphy, with a geological map of the Taconic region, by James D. Dana. In this paper the author embodies the results of a fresh study, begun in 1882, of the Taconic region extending over parts of Massachusetts, Connecticut, Vermont, and New York. The rocks described comprise the Taconic skirts of the Taconic range, and subordinate ridges within the adjoining limestone area; the limestone formations on the east and west sides of the Taconic range; and the quartzite adjoining or within the limestone area. All these rocks are regarded as belonging to one system of Lower Silurian age, with the Taconic schists as the upper member of the series. The map is to a scale of half an inch to the mile.—Variations of latitude, by Asaph Hall. The author deals with Signor Fergola's recently-proposed plan for investigating variations of latitude by special series of observations made with the best prime vertical transit instruments on selected lists of stars. A chief feature of the plan is that the work is to be mainly differential, two observatories under the same or nearly the same latitude co-operating.—Notes on the Jurassic strata of North America, by Charles A. White. The paper is mainly a reply to the objections raised by Mr. J. F. Whiteaves, of the Canadian Geological Survey against the classification of certain exposed formations frequently occurring throughout Colorado, Wyoming, Dakota, Utah, and Montana, and usually referred to the Jurassic period.—Meteoric iron from Coahuila, Mexico, by M. T. Lupton. An analysis of a fragment of this meteoric mass, weighing about 192 lbs., yielded: iron, 91·86; nickel, 7·42; cobalt, 50; phosphorus, ·27.—Optical projection of acoustic curves, by W. Le Conte Stevens. Optical presentations of a concord and a discord are shown projected on a screen by a simple and ingenious process.—Measurement of strong electrical currents, by John Trowbridge.—Divisibility of the Archæan formations in the North-West, by R. D. Irving. The region here investigated occupies, as indicated by the accompanying sketch-map, a tract some sixty miles in length between Lake Numakagon, in North Wisconsin, and Lake Gogebic, in North Michigan. The Archæan rocks of this district are referred to the Huronian and Laurentian systems.—Mineralogical notes, by W. E. Hidden. Specimens are described of phenacite and Xenotine, from new localities; of Fayalite, from Colorado; of Zircon, from Canada; and of zutile and emeralds, from North Carolina.

Nachrichten von der K. Gesellschaft der Wissenschaften und der Universität zu Göttingen, August to December, 1884.—A contribution to the theory of the absorption of light in crystals, by W. Voigt.—Remarks on the theory of the cycloid and on all forms of cycloidal curves, by A. Enneper.—Researches on the symmetrical relations and elasticity of crystals, by B. Minnegerode.—On the histology of the Asteridæ, by Dr. Otto Hamann.—On some derivatives of urea, by R. Leuckart.—On the preparation of orthodinitrobenzol in large quantities, by Paul Jannasch.—A contribution to the theory of complex dimensions developed from n unities, by K. Weierstrass.—Researches on the optical structure and properties of leucite, by C. Klein.—On some noteworthy archæological object in Treves, by Friedrich Wieseler.—Remarks on Gauss's algebraic series, by J. Thomæ.—On the titrimetric analysis of urea, by Dr. Th. Pfeiffer.—On the development of the reproductive organs in *Limax agrestis*, by J. Brock.—On the classification of the genus Loligopsis, Lam. (*Leachia Lesueur*), by J. Brock.—Remarks on the *Acta Mathematica*, edited by Dr. Gösta Mittag-Leffler, by Ernst Schering.—On the electro-magnetic rotation of a fluid, by Eduard Riecke.—On the inflexion of the present participle and comparative in Mœso-Gothic, by Leo Meyer.

SOCIETIES AND ACADEMIES

London

Royal Society, March 10.—"On 'Transfer-resistance' in Electrolytic and Voltaic Cells." By G. Gore, LL.D., F.R.S.

The existence of this phenomenon has been a matter of doubt ever since the year 1831, and the question has been examined by many investigators. In the present paper are described a series of methods by means of which its reality has been determined. Other methods are given for measuring the amounts of such "resistance," either collectively at the two electrodes of an electrolytic cell, or separately at each electrode. Modes of obviating the interference of polarisation, and of securing success in the measurements, are also described.

The influence of various circumstances upon the phenomenon were investigated—viz. strength and density of current; total resistance; density of current and size of electrode; composition of the electrolyte; strength of ditto; combined electrolytic cells; temperature; and chemical corrosion. The relations of the phenomenon to size of plate in voltaic cells, to the positive and negative plates respectively, and to strength of current in those cells, were also examined, and the results are given.

The following are the chief facts established by this research:—That a species of electric "resistance," distinct from that of polarisation and of ordinary conduction-resistance, varying greatly in amount in different cases, exists at the surfaces of mutual contact of metals and liquids in electrolytic and voltaic cells. That this "resistance" varies largely in amount with different metals in the same solution, and with the same metals in different solutions; in dilute solutions of mineral acids of different strengths, or of different temperatures, and is usually small with easily corrodible metals which form quickly soluble salts, and large with those which are not corroded; and is disguised in the case of those which by corrosion form insoluble salts.

The results of the experiments also show that the same voltaic current was "resisted" in different degrees by every different metal when employed as an anode, and when used as a cathode; also by the same metal when used as an anode and cathode respectively; and that the proportions of such "resistance" at an anode and cathode of the same metal varied with every different metal in every different electrolyte (and strength of electrolyte), and at every different temperature; and that the resistance at the anode was usually smaller than that at the cathode; in some cases, however, where a film was formed upon the anode, an apparently reverse effect occurred; that a current from a given positive plate of a voltaic cell was differently resisted by every different metal used as a negative plate in that cell; and that by rise of temperature "transfer-resistance" was usually and considerably reduced.

They further show that this species of "resistance" was largely reduced by increasing the strength of current; and was thus conspicuously distinguished from ordinary conduction-resistance of the electrolyte. In consequence of this effect, "transfer-resistance" was greatly influenced by every circumstance which altered the ordinary resistance, and thereby the strength of current. The usual effect of diminishing the density of current alone, by enlarging both the electrodes and keeping the strength constant, was to diminish the "transfer-resistance;" and of enlarging one only, was to diminish it at that electrode and increase it at the other, the effect being greatest at the altered electrode; but the influence of density was very much smaller than that of strength of current. The current was usually less "resisted," and larger with a small positive plate and a large negative one, than with those sizes reversed. Alterations of size or kind of metal at one plate of an electrolytic or voltaic cell affected the "transfer-resistance" at the other, by altering the strength and density of the current.

"Transfer-resistance," therefore, appears to vary, not only with every physical and chemical change in the metals and liquids, but also with every alteration in the current. Such "resistance" throws light upon the relative functions of the positive and negative plates of voltaic cells, and illustrates the comparatively small influence of the negative one in producing strength of current. Nearly all these conclusions are based upon results represented by average numbers obtained by series of experiments.

Linnean Society, March 19.—Sir John Lubbock, Bart., President, in the chair.—Dr. J. Grieve and Mr. Chas. T. Druery were elected Fellows of the Society.—Dr. G. J. Romanes exhibited two human crania from South Africa; one was that of an aboriginal bushman from Kruis River, Cango district, Gudtsboora, obtained through Dr. Stroud.—Mr. J. G. Baker drew attention to a specimen of a supposed hybrid between the two genera *Aloe* and *Gasteria*, and grown in the Glasgow Botanic Gardens. He also showed a curious new fern, *Polypodium* (*Niphobolus*) *polydactylon*, Hance, discovered by Mr. W. Hancock, F.L.S., in the Island of Formosa.—A paper was read on new hydroids from the collection of Miss Gatty, by Prof. Allman. Thirty-eight species distributed among twelve genera are described as new. Among these the plumularian genus, *Podocladium*, is very remarkable, not only by the possession of both fixed and movable nematophore, in accordance with which, like *Heteroplon*, of the *Challenger* collection, it holds a position intermediate between the typical Eleutheroplean and the Stetoplean genera, but by the fact that every hydrocladium is supported on a cylindrical jointed peduncle. Among other remarkable and significant forms is one to which the author gives the name of *Thuiaria heteromorpha*. In this are found combined on the same hydrophyton no less than three morphological types, which, if occurring separately, would be justly regarded as representing three genera, *Thuiaria*, *Dermoxyphus*, and *Sertularia*. Notwithstanding this singular combination of forms, the author does not believe that the characters of the specimen justifies the construction of a new genus; and he regards the generic position of the hydroid as determined by that one of the three forms which most decidedly prevailed in it. *Thuiaria heteromorpha* thus shows in a very marked way the indefiniteness of the boundaries between different zoological groups, and calls to mind a phenomena known to occur among plants, as in certain epiphytical orchids, in which the same stem has been observed to carry flowers referable to several generic types.—Then followed a paper by Capt. William Armit, F.L.S., viz. on plants met with by him on Moresby, Basilisk, O'Neill, and Margaret Islands, South Eastern New Guinea, and in which a list of over 130 species are given.

Physical Society, March 14.—Prof. Guthrie, President, in the chair.—Capt. Abney read a paper upon recent researches on radiation. In general a hot body loses heat in three ways: by conduction, by convection, and by radiation. In the case of the carbon filament of an incandescent lamp the loss of heat by conduction is insignificant, and a series of experiments has been made to determine the amount of radiation—that is, the energy expended as radiant heat for every unit of electrical energy expended in the lamp. Mr. Crookes has investigated the subject of radiation in high vacua, the cooling bodies being thermometer bulbs, and has come to the conclusion that, at pressures between 40 millionths and 1 millionth of an atmosphere, the radiation varies as the mean molecular free path. In the author's experiments incandescent lamps of thin glass were exhausted to different degrees, the radiation being measured by a thermopile. It was found that, from 40 millionths to 10 millionths of an atmosphere the radiation increases uniformly with decrease of pressure, but that beyond this point it becomes nearly constant. A more important question is to determine the amount of radiation for any particular ray under the above conditions. This was effected by placing a small thermopile in the different parts of the spectrum. Plotting the results with watts as abscissæ, and radiation as ordinates, the curves for each kind of ray are found to be very accurately hyperbolas with vertical axes. This result gives a method for rendering identical the quality of the light emitted by two lamps. We have only to find the radiation corresponding to a particular kind of light for one lamp, and then, by examining the curve corresponding to that ray for the other lamp, find for what number of watts the radiation is the same.—Prof. J. A. Fleming read a paper on characteristic curves of incandescent lamps. The author has collected a number of statistics connecting the life, resistance, efficiency, and potential difference of incandescent lamps, and has examined them with a view of showing the mutual relations of these variables by empirical equations. A curve showing the relation of any one of them to any other is called a characteristic curve of the lamp. Among the various results arrived at was the confirmation of the law, announced by Profs. Ayrton and Perry at the last meeting of the Society, that for a certain class of lamps the potential difference, minus a constant, varies as the cube-root of the efficiency, the latter quantity being measured by candles per horse-power. The constant, which, in the lamps examined, is about 28·7, is nearly the potential difference at which the lamp begins to emit light; hence the law may be put into this form: The effective potential difference varies as the cube root of the efficiency. Using the results obtained, the author then solved the problem of determining the conditions for a minimum cost per candle, and obtained a result closely agreeing with that communicated at the last meeting by Profs. Ayrton and Perry. In answer to Lord Rayleigh, Dr. Fleming stated that he had not calculated the increase of cost due to a variation from the most favourable conditions; it had been shown, however, by Messrs. Ayrton and Perry that the increase of cost due to a variation of potential difference amounting to 3 or 4 per cent. upon either side of the value corresponding to least cost was very small.—Mr. C. Cleminshaw described some further experiments on spectrum analysis. These consisted of methods of obtaining the inversion of the sodium line in the spectrum of the limelight. The first consisted in concentrating the rays from the slit by a lens, just beyond the focus of which is a spoon in which sodium is ignited by a Bunsen flame. In the second method the burner and sodium are introduced between the lime and the slit, and carbonic acid is introduced into the flame. The result in either case is to cause the inversion of the D line. Prof. Guthrie, alluding to the pale blue flame produced by common salt in a coal fire, suggested that there might be more than a mere mechanical action produced by the carbonic acid. Mr. Cleminshaw, however, believed that the action was purely mechanical.—An abstract of a communication by Dr. John Hopkinson on Sir W. Thomson's quadrant electrometer was read by the Secretary. According to Maxwell, the deflection produced by a given difference of potential between the quadrants is given by the formula—

$$d = \lambda(A - B)\left(C - \frac{A + B}{2}\right)$$

where A and B are the potentials of the quadrants, and C that of the needle. Dr. Hopkinson finds, however, that the constant λ should be $\frac{\lambda}{1 + kC^2}$, the quantity k being due to and depending on the unsymmetrical position of the needle with respect to the quadrants.

Zoological Society, March 17.—Prof. W. H. Flower, LL.D., V.P.R.S., President, in the chair.—Mr. Sclater exhibited and made remarks on a duck shot on Lord Bolton's estate in Yorkshire which appeared to be a singular variety of the Scaup (*Fuligula marila*).—Mr. W. B. Tegetmeier, F.Z.S., exhibited and made remarks on a pair of abnormal deer's antlers obtained in India.—Dr. F. H. H. Guillemard read a paper on the ornithology of the Sulu Archipelago, showing that the *ornis* of that group is purely Philippine, and that the line of separation between the latter archipelago and Borneo lies between the islands of Sibutu and Tawi-tawi. Dr. Guillemard added fifty species to the list of birds hitherto known from Sulu, two of which were new to science.—A communication was read from Mr. T. Kirsch, of the Royal Zoological Museum, Dresden, containing descriptions of some new butterflies obtained by the collectors of Mr. Riedel in Timor-Laut.—A communication was read from Prof. W. Nation, C.M.Z.S., containing some notes on the Peruvian cliff-swallow (*Petrochelidon ruficollis*).—A communication was read from the Rev. H. S. Gorham containing a revision of the Phytophagous Coleoptera of the Japanese fauna, of the sub-families *Cassidinæ* and *Hispinæ*.—A communication was read from Lieut.-Col. C. Swinhoe, F.Z.S., being the second of his series of papers on the Lepidoptera of Bombay and the Deccan. The present paper treated of the first portion of the Heterocera.—Dr. Hans Gadow, C.M.Z.S., gave an account of the anatomical differences observed during an examination of examples of the three species of rhea (*Rh. americana*, *macrorhyncha*, and *darwini*).

Chemical Society, March 19.—Dr. W. H. Perkin, F.R.S., President, in the chair.—The following papers were read:—On the presence of choline on hops, by Dr. Griess, F.R.S., and Dr. G. H. Harrow.—Fluorene, Part III., by Dr. W. R. Hodgkinson.—Combustion in dried gases, by H. Brereton Baker, B.A.

Entomological Society, March 4.—The President in the chair.—Four new members were elected.—Mr. T. R. Billups exhibited specimens of *Ceraleptus lividus*, Stein, from Chobham.—Rev. W. W. Fowler exhibited the unique specimen of *Cerylon*

atratulum, Reitt.; and specimens of an Indian *Cassida* in which the colours were preserved. Dr. Sharp remarked on the colouring matter of the *Cassididæ*. Mr. Fowler likewise exhibited a microscopical movable stage, suited to entomological purposes.—Mr. W. F. Kirby exhibited a variety of *Spilosoma lubricepeda*, Esp., which had been found in the British Museum (Natural History), South Kensington.—Mr. A. G. Butler communicated a few observations touching M. De Nicéville's recent suggestions on seasonal dimorphism in the Lepidoptera, which gave rise to some discussion.—Dr. D. Sharp remarked on the recent discovery of two different forms of spermatozoa in *Helops striatus*, Fonsc.—Papers read:—A monograph of British *Braconidæ*, Part I, by the Rev. T. A. Marshall.—Descriptions of new species of Languriidæ, by the Rev. W. W. Fowler.—On the discovery of a species of the Neuropterous family, *Nemopteridæ*, in South America, with general considerations regarding the family, by Mr. R. McLachlan.

Mineralogical Society, March 10.—The Rev. Prof. Bonney. D.Sc., F.R.S., President, in the chair.—Messrs. James Currie, Alfred Harker, and M. Alfred Lacroix were elected members.—The Secretary read a paper by M. H. Sjögren (communicated by Dr. Hugo Müller) on the crystalline character of graphite.—Mr. W. Semmons read a paper on a new discovery of connelite.—The balance sheet of the Society for the year 1884, which will be issued with the next part of the *Journal*, showed the Society's financial position to be satisfactory.

Institution of Civil Engineers, March 24.—Sir Frederick J. Bramwell, F.R.S., President, in the chair.—The paper read was on the electrical regulation of the speed of steam-engines and of other motors for driving dynamos, by Mr. P. W. Willans.

EDINBURGH

Royal Physical Society, March 18.—Mr. B. N. Peach, F.R.S.E., F.G.S., President, in the chair.—The following communications were read:—On certain peat and tarn deposits in the North of England, by Mr. Hugh Miller, F.G.S., Assoc.R.S.M.—Mr. Robert Kidston, F.G.S., described three new species of Fossil Lycopods from the carboniferous formation: *Sigillaria M'Murtrie*, from Redstock; *Sigillaria Coriacea*, from the Newcastle coalfield; and *Lepidodendron Peachii*, from Falkirk.—On the chemical composition of some samples of Scotch ensilage, by Mr. W. Ivison Macadam, F.C.S., F. Inst. Chem.—Specimens and sections of caseous tumours, found in the muscles of a hake, were described and exhibited by G. Sims Woodhead, M.D., F.R.C.P.E., who had received them from Dr. R. H. Traquair, F.R.S. These caseous masses were composed of broken-down muscular fibre, which appeared to have undergone a peculiar waxy or vitreous degeneration. Surrounding these was an area of young cellular tissue, with a considerable number of blood-vessels, and around this cellular area the muscles were undergoing the same peculiar waxy change. No parasite could be found, and it was suggested that the change might be due to violent muscular action. Dr. Woodhead also showed specimens of the liver of a fowl, in which were numerous caseous nodules. In these bacilli were found in very considerable numbers, giving the same reactions as Tubercle and Lepra bacilli. Mr. Owen Williams, M.R.C.V.S., in the discussion which ensued, mentioned that tuberculosis was often found in highly-bred fowls, and in rabbits.

PARIS

Academy of Sciences, March 23.—M. Bouley, President, in the chair.—Remarks on the map of France issued by the Dépôt de la Guerre to the scale of 1 : 200,000, with specimen sheets of a new map of France to the scale of 1 : 50,000 by Col. F. Perrier. Of the War Office map, the six first sheets, embracing the districts of Metz, Nancy, Vesoul, Troyes, Dijon, and Châlons-sur-Marne, are finished. The whole, comprising eighty sheets, 0·64m. by 0·40m., is to be completed within the year 1889, and will form a superb specimen of modern cartography.—Experimental researches on the electric excitability of the brain, properly so-called, by M. Vulpian. The author's experiments on the dog, cat, monkey, and other animals, lead him to infer that the arguments hitherto used to prove the excitability of the grey cortical substance at certain determined points are groundless, and fail altogether to support the hypothesis of local cerebral functions.—Remarks in reply to some criticisms of M. Friedel on the existence of the hydrate of chloral in the state of vapour, by M. L. Troost.—A comparative study of vessels from the standpoint of the propelling force, by M. A. Ledieu.—A simple demonstration of Lambert's theorem on the mutual action of the sun, the earth, and of a celestial body observed from the latter, by M. E. Vicaire.—On the integers of total differentials, by M. E. Picard.—Description of an electric pile acting with a single bichromate fluid, and presenting special conditions of constance, by M. Mascart.—Chemical and physiological effect of light on chlorophyll, by M. C. Timiriazeff.—Relations between the ultra-violet spectrum of the vapour of water and the telluric bands A, B, α of the solar spectrum, by M. H. Deslandres.—On the preparation of ammoniac gas, by M. Isambert.—On a monochloruretted and monobromuretted isomerous camphor, by M. P. Cazeneuve.—On the di-ethylamido-α-butyric acid, by M. E. Duvillier.—On the existence of three ganglia in the auditory nerve of man, forming a zone of cellules analogous to one of those found in the retina, by M. E. Verrier.—On a new type of Cordaiteæ largely represented in fossil vegetation, by MM. B. Renault and R. Zeiller.—A contribution to the study of the Eocene ferns in the West of France, by M. L. Crié.—On the upheaval of the Côte-d'Or range, by M. J. Martin. Contrary to the generally-received opinion, which assigns this range to a period intermediate between the Jurassic and Cretaceous, the author argues that it is in reality posterior to the latter.—Supplementary remarks on the gigantic turtles of Madagascar, by M. L. Vaillant. From the remains found by M. Grandidier at Etsere and Ambulitsate the author determines two distinct species, which he names *Testudo Grandidieri* and *Testudo abrupta*.—On the production of a new crystallised phosphate of magnesium and the corresponding arsenate, by M. A. de Schulten.—Description of the cylindrograph, a new photographic apparatus which, by a simple rotation of the objective, enables the surveyor to obtain views of the landscape embracing an angle of about 170°, by M. Moessard.

CONTENTS

THURSDAY, APRIL 9, 1885

TREDGOLD'S "CARPENTRY"

Elementary Principles of Carpentry. By Thomas Tredgold, C.E. Sixth Edition, by E. Wyndham Tarn, M.A., Architect. (London: Crosby Lockwood and Co., 1885.)

MR. TARN has for a good many years enjoyed a high reputation amongst the profession of architects as a writer upon the practical principles of building regarded mathematically. Tredgold's treatise on Carpentry has for a very long time indeed possessed the highest reputation as a much more than elementary book of reference upon that important department of building construction which deals with timber work; it has been republished time after time in the form of the old-fashioned substantial quarto which used to be in vogue before we were encouraged to expect to read as we run. It is quite in accordance with the fitness of things that Tredgold and Mr. Tarn should come together, and the English building world will scarcely require to be told that the result is satisfactory. The new edition before us is in fact a readaptation once more of the excellent material of the old standard treatise to the changing condition of our mechanical knowledge and skill. The author's mode of treating his subject has been retained intact; and we still have the well-known sections upon pressures, resistances, floors, roofs, domes, partitions, centers, bridges, joints, and timber. Whether this particular arrangement is the best, is a question scarcely worth asking, at least on behalf of the less fastidious criticism of those practical designers of carpentry who must here constitute the overwhelming majority of readers; but the editor has certainly not found it to be any bar to the importation of new matter in his own way. In one section he has introduced Prof. Clerk Maxwell's now universally appreciated system of diagrams of pressures, whereby the mere application of a common drawing scale to the component lines of easily constructed geometrical figures saves all further trouble and uncertainty in ascertaining the precise strains which the several members of a truss have to bear. In other sections the accepted formulæ of calculation, given only empirically by Tredgold, are mathematically demonstrated. The familiar tables of strength which supply the values of constants are "corrected" to accord with recent experiments more delicately and adroitly conducted, and several new tables of the kind are added. The consequent revision of Tredgold's "rules" and tables of scantlings has been thoroughly and carefully done; and various modes of more advanced construction are duly developed. That difficult subject, the theoretical thrust of domes—for in practice there ought to be none—is taken in hand mathematically, and a short chapter is added on stone vaulting. The important items of scaffolding, shoring, coffer dams, and so on, have been also introduced. The remarkable timber bridges of America—rough and ready science of the best—have been taken account of as they ought; and certain amendments which are made in respect of the plates serve in a reasonable measure to substitute new trussing for old. Lastly, the description of the nature and properties of timber is largely modified to meet the advanced knowledge of the day. With all this, the Tredgoldian character of the treatise is dutifully preserved; and so we may say it ought to be, for to modernise Tredgold too much would certainly not improve him. One of the prominent merits of the work consists in the unusually large number of illustrative plates, all to a useful scale. If these do not represent many of the more modern designs in timber work, they frequently offer examples to the student which are all the better in one respect—they exemplify that substantiality of construction which it is too much the tendency of scientific precision almost to discourage. It is a good maxim in carpentry as in most other departments of building, to make the structure not only strong but stronger than strong; and Tredgold always leans in that direction. The word *economy* is much employed amongst us; but, whereas its original and proper signification pointed only to skilful administration, its meaning with us is very much like mere parsimony. Waste of material is the bugbear of our builders, and almost still more of our architects. It need not be denied that mathematical science is in a certain way provocative of such parsimony; indeed, lightness of construction is regarded as an academical virtue in both architecture and engineering. But a moment's reflection ought to satisfy alike the most scientific and the least that true science is as much averse to parsimony of substance as common sense is. The strength of building materials can only be determined by extremely delicate experiments upon "breaking" strains, from the results of which the "safe" strains have to be deduced by estimate; and this, no doubt, becomes matter of opinion. The question is, what proportion of the breaking strain shall be recognised—almost arbitrarily—as the safe strain? With the single exception of iron, timber is the material with reference to which this matter of opinion is the most definitively settled. The reason is this:—The breaking strain must be instantaneously applied; this is essential to precision of tabulation. The safe strain is that proportion of this instantaneous breaking strain which the material will bear permanently without any risk of its elasticity being eventually overcome and a commencement made of that disturbance of the structure of the material which, once begun, increases in a geometrical ratio until the end is ruin. It is accepted, therefore, that the proportion of an ascertained instantaneous breaking strain which has to be recognised as the limit of a permanent safe strain is one-third, one-fourth, and so on, according to the character of the material. What does this mean? It means that a greater strain than this proportion would in time, with one accidental circumstance and another, produce a commencement of instability. Perhaps it is to be regretted that this question is still disposed of so empirically as it is; we might at least in these days have express observations made and reduced to what system might appear. Tredgold's rules turn very much upon the manifestations of flexure; and this, of course, is not only another way of dealing with the matter, but one which affords at any rate a basis upon which mathematical formulæ may be arrived at. On the whole, Tredgold is an old-fashioned writer, empirical and practical; but he is none the worse for that, perhaps all the better. Mr. Tarn has accepted the duties and responsi-

bilities of a scientific ally, and we have pleasure in testifying that he does his work well, and that he does not overdo it.

THE MYRIOPODS OF AUSTRIA

Die Myriopoden der Oesterreichisch-Ungarnischen Monarchie. 2te Hälfte, "Die Symphylen, Pauropoden, und Diplopoden." Von Dr. R. Latzel. (Vienna: Hölder, 1884.)

WHEN we say that the second volume of Dr. Latzel's work is in every way equal to the first we are according to it high praise. The first volume, that which dealt with the Chilopoda, has fully proved itself to be indispensable to every student of the Myriopoda, and it seems to us certain that this second volume, dealing with the other orders, must soon be accorded an even more important place in the literature of this subject. Nine years of close attention to the study of the myriopods have enabled Dr. Latzel not merely to complete a monograph of the species inhabiting his native country, but to complete it in such a manner that he has written a book which must be useful to the student of the myriopoda of any country. Not only has Dr. Latzel given minute descriptions of some 170 species, but he has also furnished tables which make it a matter of ease to determine the genus of any myriopod.

There has been unfortunately among those who have specially devoted attention to myriopods a tendency to create numerous new species on very insufficient grounds. By relying solely on characters of importance, Dr. Latzel has in great measure escaped this tendency. It is true that in the volume now under notice he has described a new genus and thirty-five new species. Possibly further observation may reduce this number; but when we remember the extent of area embraced by the Austro-Hungarian Empire, and the little attention which, comparatively speaking, has been paid by naturalists to myriopods anywhere, we must admit that thirty-five is no excessive number of new species; indeed, those who are familiar with the writings of others who have described myriopods must feel thankful that it is so small. A careful synonymy has been given of each species described; this is one of the most useful features of the book, as in this part of his work Dr. Latzel seems to us to have been singularly successful. It can have been no easy task to reduce to order the bulky mass of existing nomenclature; but Dr. Latzel has spared no pains in examining and comparing the types, generally insufficiently described, of his predecessors. It is much to be wished that some capable observer would take in hand to examine the types of the earlier English describers of myriopods, especially with regard to the Chilopoda described by Newport, and compare them with the types of Continental writers, for, so we fancy, the synonymy would be yet further reduced to order. Here we may refer to the only point in nomenclature which we regret in Dr. Latzel's book. He has adopted the specific name *venustus*, Meinert 1868, for an animal which Dr. Latzel evidently suspects to be, and which we have no doubt is, the same as that described by Leach in 1814 as *Julus pulchellus*.

One admirable feature of this work is that, where possible, full descriptions are given of the young stages of each species. As to the details of the work there is not much room for criticism. Dr. Latzel has embodied in his work the results of all recent researches into the minute anatomy of the myriopods. Embryology, indeed, has not received a very large share of attention, but references are given to all writings on the subject. Dr. Latzel differs from some American authorities in looking on Scolopendrella as a true myriopod, and places its order Symphyla as intermediate between the Chilopoda and the Pauropoda. We may here note that Dr. Latzel agrees with Menge in considering those organs which Ryder has described as tracheæ in Scolopendrella, as being merely chitinous supports for muscle-attachment. These are the same organs which Wood-Mason (*Ann. Nat. Hist.* [5] xii. 53) considers are of the nature of segmental organs.

A short notice of fossil myriopods is given, based chiefly on Scudder's researches into the fossil species of America. Scudder's conclusion seems to us to be in many points erroneous, and at any rate to be premature and based on insufficient knowledge, but as no fossil myriopods have yet been found in Austro-Hungary we can only be thankful to Dr. Latzel for dealing with fossil forms at all. The same must be said with regard to the notice of the order Malacopoda. No species of Peripatus has yet been discovered in Europe, but, though we may not agree with him, it is interesting to know that one so qualified to judge as Dr. Latzel, looks on Peripatus as forming an order equivalent to the other orders, the Chilopoda, the Symphyla, and the Diplopoda. A most useful bibliography, brought down to the date of publication, is comprised in the work. The execution of the sixteen plates, showing morphological details, is excellent in every way.

OUR BOOK SHELF

Examples in Heat and Electricity. By H. H. Turner. (London: Macmillan and Co.)

THIS is a Cambridge collection of problems and riders extracted mainly from the Smith's Prize, Tripos, and College papers of the last dozen years. The compiling (for there is nothing to be called authorship) has been, on the whole, judiciously done; and the printing is unusually clear and accurate, considering the complexity of many of the formulæ. The book is designed primarily as a help to candidates for mathematical honours, and will undoubtedly prove useful to them; possibly, perhaps, to a few private students.

But to the natural philosopher the book presents some points of curious interest. For, in these seventy pages alone, may be found (by all who know the subjects) materials for a very complete examination of one important part of the Cambridge system, alike in its present condition and during its recent development. Here and there we detect at a glance the lion-claw of the true physicist, and can, unhesitatingly, write against a question the name of Stokes, Thomson, Clerk-Maxwell, &c., so strongly marked is the individuality of these men:—who *think* in physics, thus propounding nothing unphysical; and who use mathematics as a necessary instrument of expression, neither courting nor shunning mere technical difficulties. Each of their questions stands out like a green oasis in a sandy desert! The rest of the contents (except what is but thinly-veiled "book-work") is mainly the work of *Examining Mathematicians*—the men who use physical facts (or fancies) as mere pegs on which to hang complex catenaries of formulæ; to whom $pt = Rv$ would come quite as naturally and as usefully as the laws of Boyle and Charles; the men who can *explain the result* when

the pressure of a gas or the electric resistance of a wire "comes out" negative! To such men the recent introduction of the subjects of heat and electricity by the Board of Mathematical Studies, and the appearance of Thomson's *Electrical Papers*, Maxwell's splendid treatises, and other kindred books, have been happiness indeed. Open any one of these books, at any place, and concoct from it by whatever assumptions (however unphysical) are necessary, a problem which shall lead to an elliptic integral or a Bessel's function, and there you are! This cannot long go on without seriously impairing the progress of physical science in our great mathematical university. Mathematics is, in itself, a right noble and worthy study; but the embryo physicist should, from the first, be taught to regard it as (for him) an indispensable auxiliary only, not a source of natural (?) laws. The whole procedure is thoroughly characteristic of the Cambridge of to-day. It has, among its professors and elsewhere, many of the foremost of living physicists and mathematicians, as well as others destined in time to take similar rank:—but does not utilise them. Even its *one* real test of mathematical merit, real because conducted by such men, the Smith's Prize Examination, has just been abolished! So, it has a magnificent boat at the "head of the river," but *not one member* of that crew is sent to encounter Oxford at Putney! What can be expected, either in the boat-race or in the more arduous toiling over the scientific course, but thorough and most deserved defeat?

Differential Calculus for Beginners, with a Selection of Easy Examples. By Alex. Knox, B.A. (London: Macmillan and Co., 1884.)

THIS little book deserves hearty welcome from those who are engaged in leading forward students to the higher mathematics; not so much as a substitute for any other work at present in use, but as presenting a carefully-selected set of illustrations of infinitesimals, limits, and differential coefficients, which a student may profitably work through before entering upon the usual formal treatises on the calculus.

We know of no work in English comparable with the present since De Morgan's "Elementary Illustrations of the Differential and Integral Calculus."

The special symbols of the subject are not introduced into the work before us, attention being directed to the new principles involved in the method of the calculus; indeed, the chief aim of the author throughout is to give the learner a firm grasp of the idea of a differential coefficient—a fundamental notion which, in the minds of beginners, is usually shrouded in a haze. Care is taken to deal one at a time with the difficulties which present themselves in this subject. The book is divided into twenty sections, the latter two or three dealing with successive differentiation, Maclaurin's theorem, and maxima and minima.

But before new principles or processes are introduced, an endeavour is made to insure a precise comprehension of the meaning of terms already employed by the student. And the freshness of treatment, as well as the clearness with which the author brings before the mind the exact meaning of such terms as "point," "line," "superficies," in the first section of this book, will awaken the interest and arrest the attention of even an indifferent learner.

Many of the sections are independent of each other. There is much variety of illustration, the central principle being looked at from different points of view. A distinguishing feature is the great use made of arithmetical calculations, many examples of the method of finite differences occurring.

Besides the usual geometrical treatment based on Newton's "Lemmas," the ideas of time and motion are freely introduced, and illustrations taken from elementary kinematics.

The book closes with a set of examples worked out in full, and a series of one hundred easy exercises, the answers to which are appended. A. R. W.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Rock-Pictures in New Guinea

A FEW years ago I mentioned in a paper in *Globus* (lxiii. 94) that Mr. Th. B. Leon had reported the existence of pictures on rocks he had seen in the Ogar and Arguni groups of islands (south part of McCluer inlet), and that the officer in command of H.N.M.S. *Batavia*, who had been charged to make further inquiries, had not been able to find them. At that time Mr. Leon's account had not been published in the regular issne of the *Batav. Genootschap.* Since then, however, explorations by Mr. van Braam Morris, whilst on his voyage in New Guinea in 1883, and by some of the officers of H.N.M.S. *Samarang*, have resulted in the discovery of rock-pictures similar to those spoken of by Mr. Leon. The papers giving an account of these explorations (including Mr. Leon's) have been published in a recent number of the *Tijdschrift voor Indische Land-, Taal-, en Volkenkunde* (xxix. pp. 582-591), and an abstract of their contents may be interesting.

One day Mr. Leon set out from the kampong (village) of Arguni, situated on the island of that name, for the purpose of fishing. In the beginning, on account of the surf, he kept at a great distance, but the third island of the group he was able to approach. He perceived the distinct representation of a human hand, painted in white, and surrounded with red spots, and other drawings in white, which appeared to be meant for letters, though traced in characters unknown to him. Afterwards, on penetrating between two other islands of the group, he saw several hands, all similar to the first, and accompanied by similar drawings. He was not able to land; he estimated the height of the place at which they were drawn on the rock to be from 75 to 150 feet above sea-level, the hands being about three-quarters of the way up, and the other figures about 10 feet higher still. The hands were of all sizes, representing those of children, of full-grown men, of giants, and were in great numbers. He fancied the characters bore some resemblance to the written signs in use amongst the *Orang Kling*, the *Orang Bugis*, and the *Orang Mangkasser*; they were certainly not *Javan* or *Malayan*. He was greatly puzzled as to how they could have come there, since the face of the rock was perfectly perpendicular, and without any projections or caverns, so far as he could perceive. The only explanation he can suggest is that they must have been done at a time when that part of the rock-surface was nearer to the level of the sea, or the outward form of the rock must have been changed on that side by losing ledges or projections by which the native draughtsmen may have approached the place. It will be readily understood that the natives attribute these drawings to *Kasuak*, the prince of evil spirits, who, in their opinion, has his dwelling in one of the small islands, and of whom they are naturally greatly afraid. On another island Mr. Leon discovered a huge stone, which would probably require half a dozen men to lift it, rudely shaped like a bullock, and surrounded with several other stones, evidently arranged on some fixed plan.

Mr. van Braam Morris says:—On September 16, 1883, I came to McCluer inlet, and was told by the native chiefs that the figures I was in search of were to be found on Arguni, or the islands to the west of it. I discovered them on a small island a few hundred yards from the mainland. The shores of both the island and the mainland rose perpendicularly from the water, and in the rocky face of the former, about 5 feet above high-water mark, the surf had eaten out an excavation from 3 to 5 feet wide, thus leaving a narrow platform, on which several small *prahus* were deposited, some of them being 3 feet long. Various figures were drawn on the rock above, especially hands, both of full-grown people and of children. A hand had evidently been sketched in outline from

a living model placed against the wall, and coloured to a depth of 6 inches all around it. The native chiefs who accompanied the Resident said that the remains of the Hill-Papuans had formerly been deposited here, but were now interred with Mahommedan rites; there were indications, however, that some *prahus* had been recently lodged on the platform.

Though the most astonishing part of Mr. Leon's report, viz. the difficulty of drawing the figures on the rock at a considerable height above the sea, is not encountered by Mr. van Braam Morris's experience, it is not proved that the latter explored exactly the same place as Mr. Leon. But just this point (the considerable rising of the islands) is most plainly stated with regard to the Ke Islands by Messrs. Alliol, Mol, van Slooten, Meijboom, and Deijl, of H.N.M.S. *Samarang*, which at the time of their visit lay off Tual (5° 37′ 30″ S. lat. 132° 44′ E. lat.), island of Little Ke. These gentlemen were invited by Mr. Langen, the head of the English settlement there, to visit with him the north-western part of the island; after having steamed for three-quarters of an hour they dropped anchor *vis-à-vis* Kalumit, a village at the base of a hill, about 200 metres high. They went to the top to see there some idols situated in a small settlement. I pass over this part of the narrative, and take it up after they had descended from the edge of the rock, where they had found a burial-place belonging to the kampong, which is on the top. A tolerably well-made flight of ironwood steps allowed the visitors to descend easily; after about half an hour's walk they came to the "necropolis."

On the rock near it they discovered representations in red of various figures—human hands, with the fingers spread out; imitations of human heads; a fight between men armed with *klewangs* (= cutlass), and other figures which they took to be representations of the evil spirits, outlines of ships, &c. Though the heads were rudely drawn, the hands, which were fewer in number, were remarkably well done. The place where the drawings are seem to be quite inaccessible to human beings. In the rock are also caverns which are rather difficult to approach. In one of them two gongs and some pieces of bamboo were found; at the entry fragments of broken glass had been spread, probably to prevent visitors from entering. It must be mentioned that the rock, from the base to the top, was covered with sea-shells. Attention is repeatedly drawn in the report to the circumstance that it seems incomprehensible how the pictures could have been drawn on the rock, which overhangs.

The natives connect the rock-pictures with the burial-place on the top of the cliff. Near the edge of the steep descent stand two houses, which serve as mortuaries, one being close to the dwellings of the natives, which are surrounded with a stone wall. These two houses are built of ironwood; on the roofs there are two pieces of wood, the one in the shape of a prow, the other in the shape of a keel. On the latter are two figures, a dog and a bird; a stick bearing a piece of white cloth is stuck into the bird's body. The walls are 4 and 3 metres, and in the shorter, which faces the sea, there are two doors, through which the coffin is carried; inside this hut they saw two coffins with fruits and a bottle of oil which had been left for the spirits.

The natives, who called themselves Hindoos or heathens, a name which of course has no ethnographical significance, but is merely used to distinguish them from their Mahommedan neighbours, said that when a dead body was placed in the hut the spirit was conducted by the bird or the dog on the roof to the caverns where it is to abide. In token of its arrival the animal draws a figure on the rock. The natives who accompanied the explorers durst not set foot within the caves.

It was also said that the bird and the dog were merely symbols. The soul of the deceased, on leaving the body, flies as a bird through the air or runs as a dog over the earth, till it reaches the abodes of the spirits—the caverns—unseen by living men. Every soul that reaches this haven draws a figure on the face of the cliff. In explanation of the contest between human beings and evil spirits in the pictures, they said that the latter try to prevent the souls from reaching the eternal dwellings; but they cannot hinder those who have led good and honest lives, though those who have done wickedly are carried off by the evil spirits.

The officers, judging from the many articles in gold and silver which were found in the caverns, concluded that they must formerly have been used by pirates as places of refuge and for hiding their stores, and that they were then nearer to the level of the water. On this view the drawings on the rocks would answer a double purpose: they would keep the superstitious from approaching the caves, and would also act as a landmark for the pirates themselves when returning from sea, and indicate to them the places where their treasure was hidden.

Without hazarding any opinion upon such incomplete accounts, I wish to state, merely by way of summary—

(1) That Mr. Leon's evidence, combined with that of the officers of the *Samarang*, would seem to indicate that the surfaces of certain islands in McCluer inlet and of the Ke group have been considerably elevated.

(2) That the rise has probably taken place at no distant date, but how long since cannot be determined until (perhaps) after close scientific examination.

(3) That Mr. Morris's explorations, taken in conjunction with the foregoing, suggest that the elevation is not a general one, but, though observed at distant points, is limited to certain islands of different groups, or even to particular sides of them.

Stuttgart, March 18 EMIL METZGER

Mr. Lowne on the Morphology of Insects' Eyes

PROF. LANKESTER appears to me to be fighting too much under cover. First he sends his lieutenant into the field, and then he appears himself, in the guise of an independent ally. But inasmuch as he has virtually accused the officers of the Linnean Society of having published a paper unworthy of a place in the *Transactions* of the Society, I feel fully justified in bringing him out into the open.

The anxiety expressed by Prof. Lankester on behalf of the Fellows of the Linnean Society, as to whether my paper was refused by the Royal Society, is manifestly insincere: he knows as well as I do, that the paper was virtually refused by the Royal Society. As Prof. Lankester is taking undue advantage of the secrecy which attaches to the office of referee, I shall state the facts with which I am personally acquainted, and I doubt not these will place the whole matter in a very different light from that which Prof. Lankester has endeavoured to shed upon it.

It is evident Prof. Lankester wishes to make it appear that the rejection of my paper by the Royal Society confirms his strictures and those of his lieutenant, and enables him safely to attack the Linnean Society under cover of the Royal. Now, I believe that every one who was concerned in the publication of my paper knew perfectly well that Prof. Lankester was the first referee to whom it was submitted by the Royal Society. Prof. Lankester wrote to me himself, and stated that the paper had been so referred. Although I then felt sure of its rejection, I should not have had any reason to complain, if the rules of the Royal Society had been carried out, and the paper had been submitted to a second, entirely independent referee. Prof. Huxley, in his opening address to the Royal Society on his election as President, stated that every paper was considered by two entirely independent referees. Now, in my case the second referee was Prof. Schäfer: I do not think it right to refer a paper to two colleagues intimately associated in the same school; and I am sure that no consultation should take place between the referees pending their decision. Yet Prof. Schäfer heard Prof. Lankester's adverse opinions expressed in my presence before he came to any decision himself—at any rate before making any report; and he confessed to me that he had no special knowledge of the literature of the subject on which he was called upon to give an opinion.

Under the circumstances I feel justified in stating that, if the Royal Society had rejected my paper, it would have been a rejection by Prof. Lankester; and I feel sure that an independent referee would have done exactly what was subsequently done on behalf of the Linnean Society.

Prof. Schäfer recommended me to withdraw my paper; I petitioned the Council of the Royal Society to allow me to do so, and the paper was returned to me. If this be a rejection, my paper was rejected.

I then presented it to the Linnean Society, and in so doing I told the Zoological Secretary everything that had happened. The result was that, after some delay, the paper was ordered to be printed in the *Linnean Transactions*.

I could hardly have conceived it possible that any scientific man could have descended to such a device in confirmation of his own views as to pretend that the Royal Society had formed an independent judgment under such circumstances. Prof. Lankester has succeeded admirably in rendering himself impersonal as a representative of the Royal Society—a feat which

would have no doubt incited his just indignation if it had been performed by his friend "Sludge," of spiritualistic celebrity.

I cannot help remarking on the coolness of Prof. Lankester's assertion, that my views are "undeniably based upon a mistaken interpretation of defective preparations." Prof. Lankester evidently thinks his opinion final—but he is bold to say it is "undeniable."

My sections have been seen and approved of by a great number of competent histologists and zoologists, and, although some of them are not so pretty as those prepared by the paraffin method which Prof. Lankester extols, they certainly show a great deal more. The paraffin method is well known to me, and I have examined a great number of slides prepared by it. I have possessed a series of sections so made in the Cambridge laboratory by an excellent histologist, and have rejected them as worthless: they show nothing but the connective tissue framework. Nerve fibres and nerve end organs are alike destroyed.

The whole question of the effect of reagents on the tissues is a wide one. The paraffin process destroys much which remains in the cocoa butter process, first devised by Prof. Schäfer. I esteem this process far superior to that now used in the laboratory at Cambridge, and by Prof. Lankester and his assistants. I should not fear to place my specimens side by side with Prof. Lankester's before an unbiassed histologist; and I am content to wait the decision of future observers upon my work. New views are met with little favour by those who are committed to old ones, and, whether I am right or wrong, I expect no justice from a critic who shows such determined bias as Prof. Lankester.

BENJAMIN T. LOWNE

IF Prof. Lankester imagines that he has any complaint to make against the Council of the Linnean Society for having published Mr. Lowne's paper, I must decline to consider the subject with him in your columns. He is himself a Fellow of the Society, and the anniversary meeting of the Society is due next month. If he then thinks it wise to ask any questions upon the subject, I shall be in my place and most happy to answer them.

GEORGE J. ROMANES,
Zool. Sec. L. S.

How Thought presents itself among the Phenomena of Nature

IN your issue of the 12th inst. the Duke of Argyll asks, "Is there any difference in this respect between molar and molecular motion?" namely, as regards the persuasion which most men entertain that where there is motion there must be some "thing" to move. The answer to this question appears to be the very direct one that there is the following fundamental difference between molar motions and *some* molecular motions, and that it intimately concerns that belief. *All molar motions are secondary motions, i.e.* they consist in the drifting from place to place of underlying motions (and, indeed, in the case of those motions which human beings can perceive even with the utmost aid of the microscope, they consist in the drifting from place to place of vast accumulations of such underlying motions), while, in contrast to this, *there are some molecular motions which are primary—i.e.* which have no other motions underlying them, and which do not consist in the drifting from place to place of more subtile motions.

His Grace correctly expresses the common opinion in the following words—that "an atom[1] is only conceivable as an ultimate particle of matter." Now the term "particle of matter" in this statement needs to be scrutinised. As commonly understood, it means something minute which we should be able to feel or see or perceive by some of our senses were it not for the bluntness of those senses; and this, as science shows, means that *certain specific motions* are present, viz. motions of those particular kinds which are competent, indirectly and through a long chain of intermediate steps, to finally occasion visual, tactual, or some other sensation in our minds. The statement, accordingly, as commonly understood, *really* amounts to this—that no motion can be present unless certain underlying motions are also present!

But to the uninstructed apprehension the statement has quite a different meaning, a much fuller one, and one which lies outside the domain of motion. Before they have made very careful investigation, men do not know that there is no green colour in grass or hardness in a rock. They are unaware that what is really going on in the grass is not a state of greenness, but vast myriads of motions,[1] each of which is repeated about as often every second as there are seconds in thirty millions of years, which motions in the grass occasion undulatory motions around of a like rapidity, some of which occur within our eyes, and, acting upon some compound or compounds in the black pigment which lies behind the retina, produce there an effect (probably a fugitive photographic effect consisting in some chemical change of one or more of three compounds in the pigment). This change, whatever it is, excites the optic nerve to make a stir within the brain, and *it is this last motion* (which we may safely say is utterly unlike the external phenomenon, though uniformly resulting from it through the steps enumerated above), which is what determines the perception of green in our minds. Similarly, when the vast accumulation of molecular motions which is called my finger approaches that other accumulation of motions which is called a rock, these motions act on each other, and my finger is compressed upon certain nerves, exciting them to produce those motions within my brain which, though quite unlike the motions outside, are the motions that are really accompanied by the sensation of hardness. But by uninstructed minds the colour of the grass and the hardness of the rock are confidently believed to be external phenomena, and not even phenomena of motion at all, but absolutely stationary phenomena in external Nature.

Finally, we must never forget that beliefs in the human mind, whether they be pure or mixed up with errors, can neither control nor even exercise any influence whatever upon what is really taking place in external Nature, which is the object of our investigation. What is really going on in Nature is to be ascertained, so far as it can be ascertained at all, not by projecting human beliefs into external existence, but by applying whatever modicum of dry light we can win from the slow but gradually encroaching progress of scientific discovery. And the necessity for this caution is intensified where we find, as in the present instance, that the belief has resulted from the way our brains and the brains of our ancestors have grown, under the influence of an experience of motion which has been so one-sided that it has never extended to primary motions at all, nor even to any but very coarse forms of secondary motion, omitting, along with many others, all those motions, whether primary or secondary, that occasion most of our sense-perceptions; and all this, combined with suppositions about other phenomena in which these phenomena have been quite misunderstood. Scientific scrutiny, so far as it has penetrated, finds motion throughout external Nature—motions everywhere, motions underlying every phenomenon, however different from motions some of them may seem to common apprehension; and no *scientific* investigation has as yet detected anything but motions. This is the positive side of the inquiry; and its negative side is that it would be manifestly illegitimate to draw an inference about what really exists outside us from the habits of thought which have been engendered in most human minds by a narrow and one-sided experience mixed up with palpable errors. *We, therefore, are not in a position to allege that we know of anything existing in the outer world but motions and relations between motions.*

The abstract of my Royal Institution discourse, which you were so good as to publish, only attempted to give a bare statement of the successive steps of the argument with which it deals, and I fear it is too condensed for clearness; but, as I am myself persuaded that the argument is sound, I hope that your correspondent will find that a fuller account of it which I am preparing will put all its essential parts in a sufficiently distinct light.

Dublin, March 20 G. JOHNSTONE STONEY

[1] The Duke of Argyll here employs the word "atom" in its etymological sense; and it is scarcely necessary to point out that the term when so used signifies a different thing from any of the sixty-seven complex bodies known to chemists as chemical atoms, which have intricate internal motions as betrayed to us by the spectroscope, and of which the molecules of compound bodies are known to be made up. The chemical "atom" could not under any view be spoken of as an *ultimate* particle of matter.

I understand the Duke of Argyll to propose these words as a description (not of anything the existence of which has been ascertained by experimental science, but) of that substance, matter, or thing the conception of which he and most other men believe to be the "inseparable concomitant" of the conception of motion, but for the existence of which in external nature no other evidence is forthcoming than this supposed law of human minds.

Now, even if the supposed law were a law from which we could not free ourselves, it might reasonably be maintained that it proves nothing about external existence; but in truth it is not a law, but only a widely prevalent habit of mind, as is *demonstrated* by the fact that the study of nature has extricated some minds from it.

[1] The relations which the parts of motion can have to one another or to other motions are all numerical or space and time relations. Motions may be numerous, few, simultaneous, successive, straight, curved, flat, tortuous, swift, slow, periodic, continuous, linear, or pervading a volume; but they cannot be green motions or hard motions.

Magnetic Disturbance

THERE was a considerable disturbance of the magnetograph recorded here on March 15, and had the photographic curves been developed on that day, we should probably have predicted the occurrence of the aurora seen during the evening. The earth-currents, which are necessary concomitants of magnetic disturbances, were probably intense enough to cause the disarrangement of the cable tests referred to by Mr. Willoughby Smith.

G. M. WHIPPLE

Kew Observatory, Richmond, Surrey, April 7

The Samsams

FROM a note in last week's NATURE it appears that during his recent explorations in the Malay peninsula M. Delouell claims to have discovered the "hitherto unknown" Samsam people. Allow me to state in reply that I have long been aware of the existence of these half-caste Malay and Siamese communities. They will be found duly recorded and described at p. 642 of my ethnological appendix to the "Australasia" of the Stanford Series, published in 1879. They appear to be now mostly Mohammedans, speaking what is called a mixed Siamese and Malay dialect, and otherwise forming an ethnical transition between these two races.

A. H. KEANE

University College, Gower Street, April 4

Meteor

LAST evening (April 3) I saw a fine meteor at 8h. 21m. G.M.T. ($\pm$ 1m.). I was walking along the street at the time and looking at Algol, and so only caught sight of it during the last few moments of its apparition. Its path as observed was from α 80° North δ 2° to α 76° South δ 4°, when it disappeared behind houses. It seemed quite twice the brightness of Jupiter, and about 3′ diameter; colour, chrome yellow; duration, three seconds. It left no visible train.

H. SADLER

Clapham, April 4

STEEL GUNS[1]

THE whole of this part of the Proceedings of the Naval Institute is occupied by detailed accounts of the steps taken to prepare the way for the establishment of Steel Gun Factories for the United States. We are informed that, while the rest of the world has advanced with the progress of the age, the artillery of the United States has made no step forward. Artillerists and advocates for providing adequate means of defence have laboured under many difficulties during the last twenty years, while regret is expressed that personal interests have entered so largely into the discussion of a question of such magnitude. In the House of Representatives it was declared that the fortifications of that country were in an absolutely worthless condition for all purposes of warfare.

Early in 1882 communications were opened with the owners of the chief foundries and steel works of the United States, but no firm could be found which had ever made steel guns.

At length the President of the United States was authorised and required to select six officers of their army and navy to examine and report respecting the necessary navy-yards and arsenals. Accordingly, the President named six officers (April 2nd, 1883) to form the Board of Gun Foundry, and one of their number, Lieut. W. H. Jaques, U.S.N., was elected secretary to the board. Their report was dated February 16th, 1884. The Board found it necessary to seek information in Europe, and make visits to England, France, and Russia, in order that they might reply satisfactorily to the Act of Congress. There they were well received, and had every facility afforded them in making their inquiries. The aim of Lieut. Jaques, U.S.N., in his communication to the Naval Institute, was to show the necessity of steel gun factories to the United States, to extend the information collected, and to provide a book of easy reference to the details of modern ordnance. He has produced a work which ought to warn and instruct us.

The Board in their Report give an account of the introduction of the coil system of building up guns in England; of the cost of the system to this nation; of the forty-pounder Armstrong, adopted for the navy in 1859, and of the constructing of one hundred of the 110-pounders before any experiments with them had been concluded.

Of four guns under trial, three showed a separation on the outside between the trunnion-ring and the coil behind it. The fourth showed a separation all round, but to less extent. All the guns expanded in the shot chamber and part of the powder chamber, and the *bores were elongated.* Much of these defects, no doubt, arose from excessive friction between the lead-coated projectile and the gun, which caused an unnecessary stress upon the gun.

The first visit paid by the Board was to the Elswick works. They remark: "The establishment at Elswick is thoroughly equipped for heavy work, and has produced the largest guns in the world. . . . The shops are supplied with an abundance of fine tools," page 583. They have a hammer of thirty-five tons. "The advantages of the Whitworth manufacture are also recognised, and a forging press is being introduced."

They next visited the Woolwich Royal Gun Factories, which are stated to have had in 1873-4 a capacity for the production of 6,000 tons of guns of various calibres per year. "The transition state in which the Board found the Woolwich gun factories is due to the change from muzzle-loading to breech-loading, and the substitution of homogeneous metal for the wrought coil" (page 589). The Board give a list of the chief tools in the Arsenal, as boring machines, planing machines, &c. There are four travelling cranes of 60 tons, six of 30, and six of 25 tons capacity. There are also: one steam hammer of 40 tons, one of 12 tons, one of 10 tons, two of 7 tons, besides many smaller ones. The steam power in the Royal Gun Factories is supplied by forty boilers of 40-horse power. "The plant at Woolwich, because of its transition state, contains very little worthy of imitation in planning the erection of gun factories in the United States."

The Board next visited the works of T. Frith & Sons, Sir John Brown & Co., C. Cammell & Co., and Sir H. Bessemer, all of Sheffield, and Lieut. Jaques gives full accounts of the most recent furnaces and methods employed there in working steel, illustrated with many beautiful plates. He also gives an account of the manufacture of compound armour, under the patents of Wilson & Ellis; as well as of the trials of armour plate made at Spezzia, and of granite forts protected by iron plates at Shoeburyness in 1883.

"The new departure in the system of gun construction, described farther on in this report, will demand from the Sheffield steel manufacturers increased effort. Up to the present time the only portion in the construction of the Woolwich gun that required steel was the tube. . . . The new construction requires that steel shall be used throughout, and the castings for the jackets for guns now in hand at Woolwich can hardly be supplied from Sheffield" (page 630).

It is remarked that in one important establishment preparations were being made for the introduction of a large press, to take the place, or supplement, the work of the hammer. The Sheffield steel manufacturers are entirely sceptical as to the advantage or practicability of the compression of steel in the liquid state, and although they concede the efficacy of forging under hydraulic compression, they consider it an objection to the process that a much higher temperature will be required for the press than for the hammer.

Sir Joseph Whitworth's works at Manchester were

[1] *Proceedings* of the United States Naval Institute, vol. x. No. 4, 1884. (The Establishment of Steel Gun Factories in the United States, by Lieut. W. H. Jaques, U.S.N.)

visited, where they enjoyed the privilege of carrying on their investigations within the works. "It may be distinctly asserted that the experiences enjoyed by the Board during its visit amounted to a revelation" (page 633).

"The distinguishing characteristics of the Whitworth fluid-compressed steel are homogeneity, strength, and ductility. It is made of various tempers to suit all purposes, particularly where it is exposed to sudden and violent strains. . . . No other metal possesses the same endurance" (page 633). Sir Joseph Whitworth is said to have remarked that, "Guns of enormous size are now being made at Woolwich at an enormous expenditure. . . . But if monster guns were wanted, they could be made at *far less cost* by means of the Siemens-Martin process and fluid compression. Supposing a hoop was wanted, say, 20 tons weight, the time required for its production would not, commencing with the raw material, he believes, be more than one-tenth the time required by the forging, coiling, and welding processes. . . . The Board witnessed the operations of casting followed by that of liquid compression, the enlarging of hoops, the drawing out of cylinders, and the forging of a solid ingot. The unanimous opinion of the members is that the system of Sir Joseph Whitworth surpasses all other methods of forging, and that it gives better promise than any other of securing that uniformity so indispensable in good gun metal" (page 642).

In France, as in England, the most friendly welcomes were tendered to the Board. The Government has obtained an immense increase of its resources by encouraging private industries. The foundry at Ruelle has become the principal, if not the only, establishment for the manufacture of the larger calibres designed for the navy and coast.

"It contains the most remarkable collection of tools of the age. They are designed for guns of 34 cm. (13·4 in.) and upwards, and have a capacity for handling guns of 160 tons in weight and 60 feet in length" (page 688).

"It seems as if in France the happy mean has been reached by which the Government and the private industries can work harmoniously towards the accomplishment of a national object. In a combined system of this kind, it is very important to be assured that there exist mutual checks which act to prevent one party imposing improper or hard terms on the other" (page 689).

For tubes and hoops for large guns the supply is limited to the works at St. Chamond and at Le Creusot; the former having a steam hammer of 80 tons and the latter, one of 100 tons. At Le Creusot are situated the most important steel-works in France. "At no other place in the world is steel handled in such masses, and it is safe to say that no proposed work can be of such magnitude as to exceed the resources of the establishment" (page 693). There is assembled an array of steam hammers not equalled in the world. They have three cranes capable of sustaining 100 tons, and one 160 tons. For the preparation of metal for cannon and armour-plates Le Creusot is thoroughly equipped.

Little need be said of Germany, as that country depends almost entirely upon Krupp's establishment for the supply of its guns, and the Board were not allowed to examine his works, for they were informed that the works at Essen cannot be seen, as "these are closed to all but those who have special business of inspection of war material on order." Krupp enjoys great advantages in having practising grounds at Meppen 10½ miles long, and at Dalmen of 4½ miles. Near thirty years ago Krupp planned his 50-ton hammer. He is constructing a 121-ton 16-inch gun of 35 calibres length for the Italian Government.

The Russians formerly patronised Krupp, but of late they have begun to manufacture guns at home, with the assistance of private firms. Like many of the great steel-works of Europe, the establishment at Aboukhoff is in a transition state. They possess ten steam hammers, varying from a 1-ton to a 50-ton. The most important improvement which has recently been introduced is Sir J. Whitworth's system of liquid compression.

Certain recommendations are made respecting the production of guns for the United States. As examples of a practical partnership between a Government and a private company, in working towards a national object, the experiences in England and Russia are very instructive, and warn against the adoption of such a system. As an example of depending almost entirely on private works, Germany is a perfect instance. As an example of depending alone on Government works France was a perfect instance before the Franco-German war. "How entirely France has now altered her system is shown in a previous part of this report; her present practice is theoretically perfect, and it has proved to be practically efficient. Her Government establishments are still retained, but as gun factories simply, in which the parts are machined and assembled, but for foundry work she depends upon the private industries of the country" (page 843). But still the Government is careful to secure good advice in controlling these private establishments, for on one occasion it was considered desirable to require the steel to be supplied to be subjected to additional tests. When the steel manufacturers at home resisted this the Government gave the contract to a foreign firm which was willing to comply with their requirements.

An inquiry, instituted in 1882, showed that the cost of steel construction in Europe was then as follows:—Krupp, 51 to 60 cents (26*d.* to 30*d.*) per pound; Whitworth, 38 cents (19*d.*) per pound; Woolwich guns, 30½ cents (15*d.*) per pound; Land service guns (France) 48 cents (24*d.*) per pound; but, it is added, the price of French construction has been greatly reduced (page 852).

From the short extracts we have been able to give from this most important and instructive work it must be apparent that the private firms in Germany and France are much in advance of those in England in respect of the magnitude of the steel-works they are able to execute, but only in consequence of Government encouragement and patronage. There are in those countries steam hammers in operation at least double the weight of any in use in this country. And yet, it must be remarked, these hammers are of English invention, and that the best armour-plates manufactured on the continent are made according to an English patent. The Bessemer process and the Siemens furnace are there much used. But it is equally plain that we have at Manchester and Sheffield several firms capable of successfully competing with the world, if they receive that support which a Government only can give.

After the failure of the 110-pounder B.L. Armstrong gun above noticed, it is remarkable how suddenly the system was abandoned. It was quite plain that the evil arose from the obstruction to the initial motion of the shot, and from the enormous friction all along the bore. But there seems to have been no real effort made to remedy this evil. If the lead coating did not prove satisfactory, why not rifle a condemned gun on the shunt principle and try studded shot? The original B.L. guns seem to have been much better proportioned guns than the M.L. guns which superseded them, for in a lecture delivered before the Royal United Service Institution about 1873, it is remarked that "A long B.L. 40-pounder converted into a M.L. 47-pounder is remarkable for the small amount of resistance it gives, and for its great accuracy of fire. . . . The regularity of the resistance of the air is also very remarkable," *i.e.*, when compared with the shooting of service M.L. guns of the same date. There is no known reason why this gun shot so well, except from its extra length. But the hint was not attended to. And the shortness of the English M.L. guns has been often remarked. Thus at the famous contest at Tegel, in 1868, between a 9-inch 12½-ton M.L. "Woolwich" gun costing

£1,500 and a Krupp $9\frac{1}{4}$-inch B.L. gun of $14\frac{1}{2}$ tons costing £3,453, the length of the former was 125·5 inches and that of the latter 157·6 inches. Great complaints were justly made of the unfairness of the comparative trial, because, while the English gun was strictly confined to service conditions, the German gun was repaired and altered so that every feature of the original combination was changed. After some months' delay Krupp raised the initial velocity of his gun from 1,115·3 f.s. to 1,286 or 1,414 f.s., according to whether a 336 lb. shot or a 275 lb. shell was used. Time has now decided this contest. Here we remark how ready Krupp's party were to notice defects and apply remedies. If the English party were debarred from effecting improvements at Tegel, they were free to improve at home. They had seen that it was possible to construct a $9\frac{1}{4}$-inch B.L. gun, firing lead-coated projectiles, which could compete with an English 9-inch M.L. gun. But we do not hear of any further attempts having been made to render the 110-pounder (about 7 inch) B.L. Armstrong gun an efficient weapon.

Last spring we were informed by authority that the new B.L. gun then about to be constructed would be *double the length* of the old B.L. gun. And quite recently the *Times* intimates a doubt about some newly constructed guns having sufficient strength in front of the trunnions to resist the full charge for which they were constructed. Now some years ago we heard a good deal about the doings of a Committee on Explosives, which carried on experiments for several years, and at last reported. What could be the use of such a committee if it did not furnish rules for *properly proportioning the strength* of guns, and for determining the *proper length* of bore required for the profitable consumption of charges of slow-burning powder? Although Rodman and the pressure gauges and chronoscopes appear to have failed to give reliable results, it would not be difficult to contrive experiments which would give the practical value of every inch in length of the bore, and at the same time show the effect of great length of bore upon the steadiness of the motion of the elongated projectile.

In October, 1883, it was stated in the papers that some comparative trials had been made at Portsmouth before "my lords," between a Krupp and an English 6-inch B.L. gun, "greatly to the advantage of the former." A Krupp gun fired a 64 lb. shot with a 14 lb. charge and the English gun a 100 lb. shot with a 34 lb. charge. That is, the charge of the Krupp gun was two-ninths, and that of the English gun three-ninths of the weight of its shot. This increased charge might be a positive disadvantage to the English gun if it was a short one. This is a case requiring the most careful and candid investigation. Any fine morning a thorough comparison of the performances of these two guns might be carried out in a searching manner, if only known means of doing this were employed. In order to succeed in gun-making it is absolutely necessary for careful experiments to be carried out to clear up anomalies, such as we have mentioned.

This work is illustrated by seventy-eight most carefully executed plates of guns, carriages, large steam hammers, and cranes, furnaces, plans of works, &c., and it concludes with estimates of the expenses of equipping a gun foundry according to modern requirements. F. B.

ON THE FORMATION OF SNOW CRYSTALS FROM FOG ON BEN NEVIS

In addition to the actual fall of snow, hail, &c., there is on Ben Nevis a form of solid precipitation scarcely known on lower ground, but of almost daily occurrence here. In ordinary weather the top of the hill is enveloped in drifting fog, and when the temperature of the air and ground is below freezing this fog deposits small crystalline particles of ice on every surface that obstructs its passage. These particles on a wall or large sloping surface, so well described in a recent letter in NATURE (vol. xxxi. p. 216), combine to form long feathery crystals; but on a post or similar small body they take a shape more like fir-cones, with the point to windward. Whether this deposition is from the vapour of the fog directly or from actual particles of frozen water carried along in it is not very clear. The forms and arrangements of the crystals vary according to the form of the surface to which they adhere, but all belong to this feathery or cone type, the branches lying at an angle of 30° with the main axis pointing to windward. They are formed wherever the wind blows past an obstructing body. On a flat board they gather first and most abundantly near its edges, forming a most beautiful border around it; while the centre, which I suppose the wind does not directly reach, remains clear. A round post, on the contrary, has an almost uniform crop of these crystals all over its windward half, and so accurately do they point to windward that it is possible to trace changes in the direction of the wind from the successive layers of crystals lying at different angles. The rate of growth varies with the density of the fog and the speed of the wind, but for the ordinary winds and fogs of this exposed position about half an inch per hour may be taken as a rough average. I have never seen it exceed two inches per hour. If there is a damp feeling in the air, if in fact it is mist that is passing rather than fog, the crystals are icy and hard; but when the temperature is well below freezing and the fog feels comparatively dry, they are looser in texture, seem when first formed to be attached by a mere point to whatever they are on, and are pretty easily knocked off. There is practically no limit to their growth; last winter during a long continuance of strong south-westerly winds and cold weather a post 4 inches square grew into a slab of snow some 5 feet broad and 1 foot thick in less than a week, the crystalline mass then fell off by its own weight and a new set began to form.

The effect of this growth on all the instruments exposed to its action may be easily imagined. Nothing keeps its shape or colour. The louvres of the Stevenson's screen for the thermometers become serrated with rows of teeth which quickly coalesce into a solid mass completely stopping any circulation of air inside the box. The use of exposed radiation thermometers, black bulb *in vacuo*, &c., is rendered well nigh impossible, as these delicate glass instruments would run serious risk of breakage in clearing them of the deposit, while their readings would have little value, being merely the record of the temperature inside a more or less opaque mass of snow. Very often the rain-gauge is coated with these crystals an inch thick on its windward side, while not a particle is to be seen inside. Ordinary anemometers of the type of Dr. Robinson's cup instrument become useless; the cups are no longer hemispheres, but irregular hollow bodies bristling all over with pointed crystals, and the arms carrying them increase to many times their original thickness, thus offering much greater surface for the wind to act on. Under such circumstances the anemometer at the Observatory is usually left to its own devices, and grows into an irregular mass of snow scarcely showing any trace of its original outline, to be cleared again when dry weather or a thaw gives it a chance of working. When the fog comes on while the anemometer is still turning, the crystals form chiefly on the outside of the cups and around their edges, leaving the insides pretty clear. The arms carrying the cups get completely covered, and on the diagonal stays supporting the arms the crystals show a beautiful "twined" structure pointing downwards and outwards on each side.

Occasionally the crystals are smokey-brown in colour instead of white. For example, those found on December 23, 1884, were distinctly brown, but on the 24th these were overlaid by a pure white set. What causes this

change of colour and whether it is connected with any special state of the weather I have not yet determined.

Note.—Since the above was written, I have made a rough attempt to measure definitely the rate of growth of these crystals. A cylindrical stoneware bottle 3·6 inches high and 2·25 inches diameter was stuck upside down on a post 40 inches high for three hours at a time, the crystals formed on it melted down and the volume of the water measured. Assuming that the cylinder acted like a flat surface placed perpendicularly to the wind whose height and breadth are equal to its height and diameter—an assumption that appears to be very nearly true, at least for small surfaces—I find that with dense fog and strong wind (force 6 to 8 of Beaufort's scale) the rate of growth, as measured above, is about 0·125 inch per hour. That is to say, if the density of the snow be one-tenth that of the water, the crystals were growing at the rate of one and a quarter inch per hour. The crystals were quite loose and feathery, and contained practically no fallen or drifted snow: all had been formed directly out of the fog.

R. T. OMOND

BIRD ARCHITECTURE

THE way in which a bird builds its nest, seemingly without instruction, thought, or experience, has been repeatedly brought forward as a convincing proof of blind infallible instinct governing it in its task. No more popular proof has been brought forward by the supporters of the blind instinct theory than that of bird-architecture. It is thought a wonderful thing for a bird to build a nest without any instruction, or without ever seeing a nest typical of its species. That birds are capable of such marvellous powers has long ago been denied by Mr. Wallace, and we have not a particle of evidence that such is really the case ("Nat. Selection," and Seebohm's "Brit. B.," ii. Introd.). Indeed the evidence, such as we can glean, goes far to disprove the presence of any such instinctive power. Birds brought up in confinement have been found not to make a nest typical of their species, but generally content themselves with forming a rudimentary structure—heaping a lot of material together without any design, or even laying their eggs on the bare ground with no provision at all! In my opinion, however, the conditions of life are so changed when a bird is kept in confinement that too much weight should not be attached to its actions in captivity, and the experiment has never to my knowledge fairly been tried with wild birds or birds living under normal conditions.

A remarkable instance, however, of a changed mode of nest-building has just been brought to my notice by Mr. W. Burton, the well-known naturalist of Wardour Street. Some time ago his brother (now employed at the museum at Wellington, N.Z.) took out to New Zealand a number of young birds of our common native species, with the object of introducing them to the Antipodes. Amongst them were some young chaffinches (*Fringilla cœlebs*). These were turned out and have thriven well in a wild state, bidding fair to permanently establish this charming little bird in our distant colonies. Some of the birds have built a nest; and to Mr. Burton I am indebted for a photograph of the wonderful structure they have woven. It is evidently built in the fork of a branch, and shows very little of that neatness of fabrication for which this bird is noted in England. The materials with which it is made seem very different, too. The cup of the nest is small, loosely put together, apparently lined with feathers, and the walls of the structure are prolonged for about eighteen inches, and hang loosely down the side of the supporting branch. The whole structure bears some resemblance to the nests of the Hangnests (Icteridæ), with the exception that the cavity containing the eggs is situated on the top. Clearly these New Zealand chaffinches were at a loss for a design when fabricating their nest. They had no standard to work by, no nests of their own kind to copy, no older birds to give them any instruction, and the result is the abnormal structure I have just described. Perhaps these chaffinches imitated in some degree the nest of some New Zealand species; or it may be that the few resemblances this extraordinary structure presents to the typical nest of the Palæarctic chaffinch are the results of memory—the dim remembrance of the nest in which they had been reared, but which had almost been effaced by novel surroundings and changed conditions of life. Any way we have here, at last, a most interesting and convincing proof that birds do not make their nests by blind instinct, but by imitating the nest in which they were reared, aided largely by rudimentary reason and by memory. I have not the least doubt that, had these young chaffinches been *hatched* in an alien nest in this country, and never allowed to see a nest typical of their species, or have any connection with old and experienced birds, the results would have been still more startling and strange. Man has to *learn* the particular art of house-building practised by his own peculiar race —birds have to do the same!

CHARLES DIXON

THE INSTITUTION OF NAVAL ARCHITECTS

THE Annual Meetings of the Institution of Naval Architects were held during the week preceding Easter at the rooms of the Society of Arts. There were five sittings, at which the necessary routine business was transacted, the presidential address of Lord Ravensworth was delivered, and seventeen papers were read and discussed. On the whole the meetings were successful and the papers of good quality, but far too much work was attempted in the time available. It is to be hoped that the growing importance of the proceedings and the improving financial position of the Institution may lead the Executive to arrange for holding regular autumnal sessions at the principal outports, in addition to the spring sessions in London.

The papers read were chiefly "papers of information," having a strictly practical or descriptive character, only two or three having scientific pretensions. Marine engineering also occupied a far more prominent place than has been usual hitherto, nearly one-half of the papers having relation to the propelling apparatus of steamships. The fact is significant, indicating the remarkable progress which has recently been made in marine engineering, and suggesting the progress which may yet be made. Of the papers coming into this group, that by Mr. Macfarlane Gray, of the Board of Trade, was the only one of a scientific nature. Mr. Gray has on more than one occasion brought his "ether-pressure" theory before the Physical Society, where it has not been well received. His recent paper "On the Theoretical Duty of Heat in the Steam-Engine" was probably understood by only a few of his hearers; and Prof. Cotterill, whose authority on the subject is undoubted, was the only speaker who really contributed any useful criticism. While complimenting Mr. Gray on some of his graphic processes, and expressing admiration for his courage and perseverance, Prof. Cotterill took exception to the generalisations attempted in the paper and to the assumption that the results so far obtained were any real confirmation of the soundness of the theory advanced.

All the other engineering papers were of a practical character. The actual performances of "triple-expansion" engines as compared with the "double-expansion" or ordinary compound marine engines, were discussed at length. Experience appears to be conclusive on the point that, by using steam of 120 to 150 pounds' pressure, and having three successive expansions in separate cylinders, an economy of from 15 to 20 per cent. in coal consumption is to be realised. This economy is of the highest importance, both in mercantile and war ships

and on long ocean voyages its effects are felt, not merely in the lessened expenditure of coal, but in the gain in cargo-carrying capacity. Twenty-five years ago an expenditure of from 4 to 6 pounds of coal per indicated horse-power per hour was considered good engineering practice. By the introduction of surface-condensers the expenditure was reduced to about 3 to 4 pounds; by the use of the compound engine with higher steam pressures the expenditure fell to about 2 to $2\frac{3}{4}$ pounds; and now with triple expansion it has been brought nearly to $1\frac{1}{2}$ pounds, or less than one-third of the rate common a quarter of a century ago. These are results of which marine engineers may be proud, and which make the extended use of steamships certain. Nor is further progress to be doubted. Much remains to be done in improving the marine border, and Mr. Milton's thoughtful paper on the subject will do good. Attention has been so fixed on the economical use of steam in the engines, that the possible gains by improvements on the generators of the steam have been overlooked to some extend. The employment o forced draught" in the stokeholes is becoming so common, that it was to be expected that a discussion would arise upon it. Mr. Robinson read a paper describing a method by which steam yachts might have the combustion quickened by driving air under pressure into the furnaces, but not closing in the stokeholes as is done in torpedo boats. This paper was not merely interesting in itself, but served the useful purpose of calling forth some valuable statements of experience gained on larger ships. Forced draughts with closed stoke-holes is now becoming a recognised feature in warship design. By these arrangements, involving very moderate additions of weight and cost, the indicated horse-power can be increased by from 50 to 60 per cent. above that obtained with natural draught, and the "forcing" of the combustion can be carried on for four or five hours. A very considerable gain of speed is thus possible for a moderate time, and under ordinary working conditions with low speed, the economical expenditure of fuel is possible. In special types of merchant ships forced draught would also prove of great value; and even in sea-going steamers something of the kind is likely to be done. Trials are already in progress which promise a great economy in the weight and space required for the steam boilers, while preserving economy in coal consumption. A paper by Mr. Linington, of the Admiralty, on the propelling machinery of high-speed ships, gave a considerable amount of information as to recent Admiralty practice; and another paper by Mr. Joy, described a special arrangement of valve gear adapted for quick-running engines. Upon the efficient working of such gear, and the proper distribution of the steam, very much depends when high piston speeds are accepted, and the weight of machinery reduced.

Mr. Thornycroft's name will always be associated with the introduction of the modern torpedo boat, in which quick running engines of remarkable lightness in proportion to their pow.r are fitted. His paper on a special form of screw propeller suitable for vessels of very shallow draught and relatively high speed naturally attracted great attention. The fundamental principle of this propeller is not a novelty: but Mr. Thornycroft has brought to a practically successful form what has been little more than an experiment in the hands of others. The propeller is one which works with a large amount of "slip," but it is associated with a system of fixed "guide-blades" and casings, by means of which the momentum of the water in the propeller race, which would otherwise be wasted, is made to contribute effectively to the forward thrust of the propeller. The net result of the arrangement is that for a given total weight of propelling apparatus a higher speed can be obtained than is possible with any other propeller yet tried in shallow draught vessels.

Mr. Parker, of Lloyd's, read a paper on the use of thick steel plates for boilers carrying high pressures of steam, with special reference to a case of recent occurrence where a plate fractured badly and in a most unexpected manner. This paper gave rise to one of the most lengthy and interesting discussions at the meetings. Steel makers and users of steel mutually benefit by the joint examination of such problems, which will probably become much rarer than they now are as the manufacture advances. The general opinion expressed in the discussion was distinctly in favour of the generally good behaviour of the new material, whose superior strength, ductility and homogeneity make it so formidable a rival to the best classes of iron.

Two papers on riveted joints were well received: the first giving a *résumé* of recent Admiralty experiments on riveted specimens of steel shipwork; and the other dealing with certain points of importance in the riveting of boiler shells.

Amongst the remaining papers, one, dealing with the stowage of steamships, contained a mass of valuable facts. Another paper dealt with the possibility of making such a disposition of the coal bunkers in steamships that the consumption of the coal might not prejudice the stability or render large quantities of ballast necessary. A third was a scientific attempt to lay down rules for competitive yacht-rocking—a hopeless task we fear.

There still remain to be noticed three of the most important papers in which a distinctly scientific method was followed. Undoubtedly the best of these, from the scientific point of view, was that contributed by Mr. Watts, in which he examined into the remarkable effects which free water may produce in checking the rolling motion of even the largest ships. Mr. R. E. Froude assisted greatly in the investigation, and exhibited a model in which the behaviour and influence of the free water were admirably illustrated. It seems obvious that by this means much greater steadiness at sea may be insured than is possible with bilge keels or other appliances of that kind. But there is a need for scientific treatment in order to secure the best steadying effects in a safe and practicable form.

Another excellent paper was that on "A Mechanical Method of Measuring a Vessel's Stability," by Mr. Heek. Here also a model was used, and by a very ingenious device the movements of the centre of buoyancy of the ship represented by the model were accurately and simply determined for all angles of inclination. It is a method which can be used by comparatively unskilled assistants in a drawing office, although its invention is a proof of thorough knowledge of the principles of stability on the part of the inventor. The plan ought to be widely used, and doubtless will be.

Finally, reference must be made to the only paper contributed by a naval officer, Capt. Noel, in which he attempted to lay down rules of general application for measuring the "fighting efficiencies" of war-ships of all classes and sizes, differentiating their values according to the nature of their speeds, manœuvring powers, armaments, protection, seaworthiness, and other qualities. The task is seemingly a hopeless one, and no general rules can apply. At the same time the paper sets out clearly and succinctly the leading characteristics on which fighting efficiency depends, and in that sense will be of service to the Institution.

W. H. W.

THE EGGS OF FISHES[1]

CONSIDERABLE advances within comparatively recent times having been made in regard to our knowledge of the spawning of fishes, and the treatment of

[1] Introductory Lecture delivered to the Class of Natural History in the University of St. Andrews, on November 10, by Prof. McIntosh, LL.D., F.R.S.

their eggs after deposition, I have selected this subject for the introductory lecture, since some opportunities have lately been afforded for its investigation in our own waters. These facilities have occurred at sea in connection with the Trawling Commission, and on land at the Marine Laboratory—now, I am glad to say, established, by the aid of the Scotch Fishery Board, within easy reach of the students of Natural History in this University.

The subject, moreover, is one of general interest, for it is but a short time since works devoted to the history of British fishes were devoid of allusion to any other mode of spawning than that by which the eggs of our marine fishes were deposited on the bottom of the sea. Indeed, it was believed by most naturalists that the latter was the normal mode of deposition. As a consequence, some of the text-books at present in use either follow the latter view, or do not specially allude to the question. Under these circumstances, it is not surprising that the majority of those who have spent their lives from boyhood onward at the pursuit of line-fishing should maintain, even at this moment, that the eggs of all marine fishes are deposited at the bottom of the sea—with a tenacity all the more persistent as several apparent corroborations by experiment (which they had, with praiseworthy interest, made, and which I shall allude to by and by) seemed to justify their opinion.

The eggs of all fishes are produced in the ovaries—symmetrical organs which lie beneath the vertebral column, and which at different periods of the year present various appearances according to the degree of development of the eggs. Thus in the quiescent condition of the organs, as in the case of the green cod before you, their size is insignificant, while the fully-developed ovaries occupy a large space and weigh several pounds. At first the eggs are very small, but they gradually increase in size by imbibing nourishment from the ovarian follicles in which they are placed.

A feature not sufficiently insisted on in our country is the fact that only a portion of the ovary in most marine fishes becomes "ripe" at a given time, the matured eggs passing along the oviduct and escaping externally. This provision appears to be admirably suited for the increase of the fishes, a constant succession of embryos being thus liberated, and time afforded for those of one stage to disappear, as we shall afterwards see, from the surface of the ocean before those of the succeeding take their places. In America this condition has been clearly described in the Report on the cod-fisheries of Cape Ann, by Mr. Earll, for the United States Fish Commission in 1880; but the account does not seem to have come under the notice of Mr. Oldham Chambers, who alluded to the subject a year or two afterwards.[1] Mr. Earll observes that the individuals (*i.e.* the cod) do not deposit all their eggs in a single day or week, but probably continue the operation of spawning over fully two months. The result of this arrangement is that the American cod begin to spawn in September, and some continue as late as June. The cod in our own seas do not follow the same habit, though their spawning-period extends on each side of the beginning of April. In the same way the period during which the eggs of the various kinds of skate are deposited is considerably lengthened.

On the other hand, such marine fishes as the lump-sucker and bimaculated sucker, the salmon, trout, and most freshwater fishes seem to deposit their eggs within the limited period of a day or two, and consequently the development of the masses of eggs in the ovaries is more nearly simultaneous.

The importance of this point in the history of the eggs of fishes will be apparent when it is viewed in connection with a close time in legislation; for while nothing could be more simple than the fixing of such a period in the case of the salmon, which spawns in rivers, it would be very different in the case of such as the cod, sole, and turbot, both on account of the lengthened and diverse periods in each case, and the vastness of the field in which it is to be applied.

In general form the eggs of ordinary fishes are circular. On deposition they are usually invested by a single layer (zona radiata), though in some, as in the herring, there is another, viz. the vitelline membrane, which lies outside the former. The great mass of the egg is formed by the oval spherules of the food-yolk, which are separated by protoplasmic bands. Near one of the poles the protoplasm usually forms a lenticular area, the germinal disk or germinal area, and the smaller yolk-spherules in this region differ in character from those of the general mass of the egg. During development the eggs show partial segmentation, this process being chiefly confined to the germinal area.

While the circular form as just described is characteristic of the eggs of most fishes, we have a few marine types which deviate from the general rule, *e.g. Myxine* (glutinous hag), with its ovoid and fringed eggs, the goby, with its fusiform ova, the gar-pike, saury pike and flying-fish, which have long filaments attached to their eggs—probably for the purpose of fixing them to floating structures of any kind. Amongst other interesting types are the large eggs of the stickleback and the salmon-tribe, and the almost microscopic eggs of the eel. The large ova of the salmon and trout are surpassed, however, by those of the Siluroid genus *Arius*—found both in the Old World and the New (Ceylon and Guiana)—the eggs being somewhat larger than a pea (5-10 mm.): but this is not the only remarkable feature in these fishes, for, as Drs. Günther and Wyman and Prof. Turner have shown, the large eggs are carried by the male in his mouth and gill-chamber until hatched, the small and almost granular palatine teeth making this possible, without injury to the ova. He thus acts the part of a dry nurse, as also does the male pipe-fish (*Syngnathus*), and the sea-horse (*Hippocampus*), the eggs being borne by the male in a pouch on the under surface. In another Siluroid fish (*Aspredo*) from Guiana the remarkable exception occurs of a female fish interesting itself in the care of its young. The skin on the under surface becomes soft and spongy, and the eggs, which are deposited on the ground, adhere by simple pressure of the body over them—very much after the arrangement in the Surinam toad. Only one other female fish shares with this one the distinction just noted, viz. *Solenostoma*, an Indian Lophobranch, in which the ventral fins (free in the male) coalesce to form with the integuments a pouch for the reception and hatching of the eggs. The entire group of the sharks and rays (Elasmobranchs), again, is characterised by the peculiar condition of their eggs, which are not only distinguished by their great size, but by the fact that they are either deposited in horny capsules, or retained in the oviduct until hatched. The former takes place in the common rays, certain dog-fishes (*Scyllium*), and sharks (*Cestracion*), and in the curious *Chimæra* and *Callorhynchus;* while the latter, that is the production of living young, occurs in the rest of the sharks and in *Torpedo*.

As already indicated, the prevalent notion amongst the older naturalists was that fishes of all kinds deposited their eggs on the bottom of the sea, and that extensive migrations were made by various kinds for this purpose, the general impression being that the majority proceeded shorewards to deposit their eggs in the shallow water. This impression was probably due to the fact that the salmon, and perhaps the herring, followed this habit, the former proceeding up rivers, and the latter selecting certain suitable banks (often near land) covered with seaweeds and zoophytes, or a bottom composed of stones and gravel. Building their notions on these facts, it was

[1] "Fish and Fishes," Prize Essays, International Fisheries Exhibition, Edinburgh, 1883, p. 187.

assumed by the older observers that all marine fishes followed similar habits. Thus it was supposed that the cod, haddock, whiting, ling, hake, and other fishes frequented certain banks for the purpose of depositing their eggs, and that various flat fishes, such as the larger examples of turbot and sole, came from deep water to shallow water for the same end. Such conjectures, however, were found to deviate very considerably from the actual condition.

Amongst the earliest to notice that the eggs of certain marine fishes floated were the cod-fishermen of the Loffoden Islands, off the coast of Norway. These Norwegians had noticed that what they called the "roe" of the cod-fish floated in the water on the great fishing-banks, and often at certain seasons to such an extent as to make the water thick. Prof. G. O. Sars, Inspector of Fisheries in Norway, to whom this remark was made, supposed that the fishermen had mistaken some of the lower marine animals for the eggs of fishes, for such a feature was in direct opposition to anything he knew of the spawning of fishes. The subject, however, was soon set at rest, for he proceeded in 1864 to the fishing-grounds above-mentioned, viz. off the Loffoden Islands, and captured in the tow-net immense numbers of the eggs of the cod floating at the surface of the sea. Next year, indeed, on a calm day, Prof. Sars found the sea covered with a dense layer of floating spawn, so that with a sufficiently large net he could have taken tons of it. This occurred over a celebrated fishing-ground, on which the cod were present in enormous numbers, so as to form what the fishermen called a "fish mountain." Sars also found that the ova of the haddock floated, and amongst the eggs procured from the surface of the sea were some from which young fishes resembling gurnards emerged, and he correctly concluded that the ova of the gurnard followed the same habit as those of the cod and haddock.

The impetus given to such observations by the energetic action of the United States Fish Commission enabled the Americans to corroborate the discovery of the Norwegians in regard to the floating of the ova of the cod, which lately have been artificially hatched on a somewhat extensive scale on their coasts. The labours of the distinguished Prof. Alex. Agassiz in the same country have further added to our knowledge of floating eggs, so that the number of fishes in which this occurs is considerable. Thus the majority of the American flounders, certain kinds of wrasses (*Ctenolabrus*), a species of sparling (*Osmerus*), several species of cottus, cod, haddock, gurnard, shad, mackerel, and Spanish mackerel, a kind of dory (*Zeus*), and the frog-fish are amongst those which have floating eggs. The late Dr. Malm of Gothenburg further increased the list by discovering that the eggs of the plaice were similarly buoyant; and G. Brook has recently added to this category the eggs of the lesser weever. The very great influence which this floating of the tiny eggs exercises on the multiplication of the food fishes will be apparent as we proceed.

On the other hand, most freshwater fishes (except the shad) deposit their eggs on the bottom like the salmon, or on water-plants, like the carp and pike; while other marine species, such as the herring, sprat, lump-sucker, and bimaculated sucker, follow a similar method. The number of marine fishes which are supposed to deposit their eggs on the sea-bed is yearly diminishing, while the ranks of those in which the ripe eggs are found to float correspondingly increases.

To come now to our own shores, and to confine our remarks to what is really the most important group of fishes, viz. the food-fishes, we find that early in spring the surface of the sea over the great fishing-banks, such as Smith Bank, off the north-east of Scotland (Caithness), presents vast numbers of floating eggs of food-fishes, together with multitudes of the very young fishes provided with a yolk-sac exhibiting various degrees of absorption. Some of the ova (*e.g.* those of the haddock and gurnard) are larger than those of the cod, but they are few in number; while a fourth kind are smaller than any yet mentioned. When placed in a vessel of sea-water the eggs persistently float on its surface, descending but a very little when the jar is rudely shaken. Even after a protracted journey only the dead eggs roll on the bottom of the vessel. All the floating eggs are living. Moreover, the eggs were removed from the cod itself, and carried from Smith Bank to the Marine Laboratory at the harbour. On arrival, these floated at the surface of the vessel. On transferring them to a larger jar and turning on a tap of sea-water, a great change occurred. The ova in a few minutes lay on the bottom. Microscopic examination subsequently showed that the edge of the germinal area was disintegrating—free protoplasmic processes and separate cells occurring all round. The cause of this sudden change was doubtless the impurity of the water (for the proper apparatus had not yet been fitted up), the metallic pipe (block-tin) containing an opaque whitish deposit which speedily killed the ova. The addition of methylated spirit in the same way sends all the eggs and embryos to the bottom. Sars, indeed, mentions that if the eggs of the cod are placed in fresh water they sink, and never rise again. They are killed—just as a newly-hatched salmon is killed—though somewhat more slowly, by immersion in sea-water. Sars thinks that even a fall of rain might affect the floating of the ova in the sea, but this is unlikely.

More than once the eggs of the haddock and other fishes have been brought under notice as lying on the bottom of a vessel, and therefore held as proving that the ova did not float. But in every case such eggs were found to be dead or dying, unripe, or not even fertilised. If in removing the eggs from a fish, too much pressure is applied, unripe eggs escape. Such either sink or float ambiguously, according to the stage of development. Unless this fact is borne in mind, disappointment naturally occurs, especially to one who has triumphantly carried such eggs from deep-sea fishing to vindicate statements that have been impugned. No one ever asserted that dead eggs floated. It is the ripe and living eggs that are so buoyant.

In the Marine Laboratory it has happened that some living ova of the cod rolled on the bottom of the vessel, but this was clearly due to the attachment of fine particles of mud and sand which had gained admission from imperfections in the temporary apparatus, and which surely and speedily in every case proved fatal to the embryo.

The ova and embryos brought from the surface of the sea are comparatively hardy, even though kept for ten days without renewal of the sea-water. The lively little cod, about 5 mm. in length, with their characteristic black pigment-patches, swam actively at the surface of the water, darting hither and thither when interfered with, while a stratum of the dead lay at the bottom. The water may even be somewhat milky and the odour characteristic, and yet the embryos survive—until, as Sars also found, the yolk-sac, which supplies them with nourishment, is absorbed.

The difference between the larval cod and the young salmon just hatched is striking. The former (that is, the young cod) is in a very rudimentary condition, not only in size, but in structure. For instance, the heart pulsates, but, as my colleague, Prof. Pettigrew, observed, there is no visible blood and no blood-vessels. Those, therefore, who say that the heart in animals contracts from the stimulus of its living blood, would here find little support. On the other hand, the newly-hatched salmon has attained great complexity; indeed, several days may be spent in delineating its elaborate blood-vessels alone.

(*To be continued.*)

NOTES

WE regret to learn of the death, at the age of eighty years, of the eminent physiologist, Prof. Karl von Siebold, of Munich.

WE have also to announce the death of Mr. Frederick Field, F.R.S. Mr. Field was one of the original members of the Chemical Society. He held for some time the post of Vice-Consul in Caldera, Chili, and was successively Professor of Chemistry at St. Mary's Hospital and the London Institution. He was senior partner of the firm of J. C. and J. Field at the time of his death. Mr. Field contributed numerous papers to various branches of chemistry, especially that relating to the mineralogy and metallurgy of South America.

A COMMUNICATION dated March 7 has been received from Mr. Thorlacius, observer for the Scottish Meteorological Society at Stykkisholm, in which he states that till February the winter in Iceland was not a severe one. In that month, however, the weather was very cold, and ice between six and seven feet thick formed in the harbour, during which of course no temperature observations of the sea could be taken. On March 4 and 5 the ice broke up, and in the open space between the floating ice-blocks the temperature of the sea was found to be 29°·0. Of the Spitzbergen ice it is remarked that nothing had yet been heard of it, but that it could not be far off, as north-easterly winds had been blowing all February. Mr. Thorlacius observed an aurora on January 24, with a triple arch and faint traces of a fourth bow within the other three arches close down on the horizon, being the first time an aurora of this description has been seen by him since he began his regular meteorological observations in 1845.

THE *Monthly Weather Review* of the Dominion of Canada for February, 1885, presents some points of interest. At Victoria, British Columbia, the mean temperature was 9°·0 higher than the average, and 13°·8 higher than February last year; but, on the other hand, to the east of the Rockies, temperature was under the average, the greatest defect from the average, 13°·3, occurring at Port Stanley. At Toronto the mean temperature was only 11°·1, being 11°·1 lower than the average of forty-five years, and with the single exception of February, 1875, when the mean fell to 10°·2, was the coldest month recorded at the observatory during the past forty-five years. Generally the month was remarkable for the cold which prevailed nearly everywhere, and also for the very stormy weather which was experienced over the Lake Region, and in Eastern Canada, between the 8th and 11th. On the 9th temperature fell in Manitoba to −48°·3 at St. Andrew's, and −46°·0 at Stony Mountain; and in Asiniboia to −47°·0 at Pheasant Forks. The proportion of sunshine recorded in each hour of the day during which the sun was above the horizon is given for twelve stations, giving a mean result of 39 per cent. of actual as compared with possible hours of sunshine. It is remarkable that only at one of the twelve stations, viz. Cornwall, was 100 per cent. recorded during any day of the month. The number of predictions or forecasts of weather issued during the month was 523, of which 80 per cent. were fully, and 92 per cent. either fully or partially, verified. As regards the three storms which occurred, thirty-nine warnings were issued and cautionary signals at the various signal stations, each of which was verified in every particular as to the force of the wind; and with respect to the predictions as to the probable changes in the direction of the wind, 90 per cent. were fully and 100 per cent. were either fully or partially verified.

MR. CUTHBERT E. PEEK sends us his First Report of a meteorological observatory established at Rousdon, Devon, in September, 1883. The Report presents some of the features of the meteorology of Rousdon during 1884. Fully half a quarto page is given to a somewhat popular account of the weather of each month. A few illustrations are given, of which the first shows by curves the mean monthly temperature of Greenwich for the forty years ending 1873, and the mean at Rousdon for the months of 1884. Nowhere, however, is there printed in figures a monthly mean either of the pressure or the temperature of the air, the author contenting himself only with the extreme pressures and temperatures of the months. Subsequent reports will, no doubt, make good these omissions, and will continue, it is hoped, the comparison of the weather forecasts of the Meteorological Office, with the weather actually experienced in this district of Eastern Devon.

THE veteran zoologists of Cuba, *Science* states—Prof. Felipe Poey, who is now nearly eighty-six years old, and Dr. Juan Gundlach, who has completed his seventy-fourth year—are still engaged industriously in studying the fauna of that tropical island. Dr. Gundlach has been publishing his contributions to the fauna of Porto Rico in the *Annals* of the Spanish Society of Natural History. The vertebrates (including fishes by Poey) have all appeared, and recently the freshwater marine mollusca have been issued. Gundlach has been publishing every month eight octavo pages in the *Annals* of the Havana Academy of Sciences—a contribution to the mammals, birds, and reptiles of Cuba—and is now at work upon the insects, of which the Lepidoptera are already nearly completed, and occupy already nearly 400 pages. Poey has published the fishes of the island in the *Annals* of the Spanish Society of Natural History, and Arango has discussed the mollusks. It is to be hoped that these still vigorous naturalists will live to see the completion of the work they have undertaken with so much zeal.

THE French Academy of Sciences has appointed a new commission on aërostats consisting of MM. Faye, Fremy, Jamin, Tresca, Cornu, and Perier.

THE French Society of Physics will meet as usual to-day, in the rooms of the Société d'Encouragement, to exhibit all the new apparatus invented during the year.

PROF. TYNDALL will begin a course of five lectures at the Royal Institution on Tuesday next (April 16) on "Natural Forces and Energies."

THE arrangements for the remaining April Popular Science Lectures at the Royal Victoria Hall, Waterloo Road, are as follow:—April 21, P. H. Carpenter, D.Sc., on Greenland. April 28, Dr. J. A. Fleming, "Our Nimble Servant, Electricity, and what we can make it do."

EXHIBITS in the Fish Culture Department of the forthcoming Inventions Exhibition are already being placed in the several spaces allotted to them. They include hatching-boxes showing the manner in which fish eggs are incubated; feeding-boxes in which the fry are inserted after losing their *umbilical sac*, and numerous appliances and apparatus necessary to carrying on the work of fish-culture successfully. There will also be shown various species of fish in different stages of development reared artificially, together with models of fish-farms, oyster-culture establishments, and a number of other exhibits of an interesting nature.

A COMMISSION appointed by the French Government to inspect the forests of Tunis, and to make proposals with regard to afforestation, has recently presented its report. In the districts south of the Medjerda valley the so-called forests are mere brushwood, composed of the callistus, juniper, Aleppo pines, and small oaks. The land is cleared for pasturage and cultivation, and only here and there are seen groups of larger trees, such as Alpine firs and olives Nothing is therefore to be gained by preserving here, and the cost would be very great;

but it is nevertheless recommended that some steps be taken to protect trees and shrubs which exercise a beneficial influence on the *régime des eaux*. The Kroumis mountains to the north are of a totally different character. Magnificent forests of old trees exist in them, which attain as great dimensions as those in the best French forests. They contain magnificent cork trees and white oaks (*Q. Mirbeckii*), with trunks three or four metres in circumference and ten to fifteen metres in height to the first branches. One forest covers 100,000 hectares, and contains also the alder, willow, wild cherry, beech, poplar, holly, bay, and the tamarisk. This and some neighbouring ones should, the report advises, be strictly preserved. The bark and wood of the oak and cork would repay the expense.

WE have received Mr. Morris's Annual Report on the Public Gardens and Plantations of Jamaica, which, as usual, contains various matters of much general and local interest. We have already referred, in noticing a similar report from Queensland, to the immense economical importance of such institutions as this, and we are glad to perceive that such competent authorities as the late Royal Commissioners in the West Indies and Sir Joseph Hooker have publicly recognised the value of Mr. Morris's labours. The former suggest that in all the lesser islands "plant committees" of the residents should at once be formed to correspond with the establishment in Jamaica, while Sir Joseph Hooker, in commenting on this recommendation in his letter to the Colonial Office, stated that there can be no doubt that the future prosperity of the West Indies will be largely affected by the extension to other islands unprovided with any kind of botanical establishment of the kind of the operations so successfully carried out by Mr. Morris in Jamaica. But he thinks that mere committees will not be enough: botanical stations on a cheap basis are an essential condition for doing anything in an effective way. The money value of rain in Jamaica is well shown in a paragraph in the report quoted from Mr. Maxwell Hall's estimate. A comparison has been made between so many inches of rain per annum and so many casks of sugar per acre. Thus there were 1559 casks per acre for 79 inches rainfall and 1441 casks with 56 inches, so that the difference due to a larger or smaller island rainfall is on an average nearly one-tenth of the export sugar crop. This one-tenth export crop, for sugar and rum, represents in value nearly 100,000*l*. But if other produce, which is likewise affected by a greater or less rainfall, such as coffee and pimento, the difference would amount to a very considerable sum. During the year considerable attention was devoted in the herbarium to the medicinal plants of the island, and to forming not only a collection of botanical specimens, but also of the barks, roots, and the portions used for medicine. The value of this herbarium to the commercial interests of the West Indies was shown while working up the botanical classification of the indigenous plants capable of yielding fibre. It was found that the common native *Agave* (aloe) of Jamaica was not, as had been represented in books on Jamaica plants, the *Agave americana*, but an entirely different species, the *Agave keratto* of Salmdyck. The application of this difference, which appears to him only one of botanical nomenclature, to the industrial arts is that, under the belief that this plant was *Agave americana*, and therefore capable of yielding valuable fibre, large sums of money were spent and lost in getting out machinery to clean fibre which was of inferior quality.

AT the end of the report on the Jamaica public gardens above referred to, Mr. Morris mentions some curious instances of superstitions among the negroes with regard to plants. The plantation labourers believe that if they take up the horse-plaintain suckers (*i.e.* those with long fingers), and then take up one of the maiden plaintains (with the short fingers) while the gum or juice is still fresh upon their cutlasses, and they use the same cutlass, the maiden plaintains will produce horse-plaintains, and this was said by them to be a matter of common experience. It is believed also to be unlucky to point the finger when speaking of any growing plant in a provision ground, or even to name a plant which has recently been planted. It is stated even by intelligent Europeans that if the seed of the shaddock (*Citrus decumana*) is planted, there is but one in a whole shaddock that will produce good and pleasant fruit, and also that there are fifty-two seeds in a shaddock, only two of which produce the real shaddock, while the others produce a variety of fruits such as the sweet lime, forbidden fruit, grape fruit, chester fruit, and orange!

ACCORDING to an article in the last number of the *Oesterreichische Monatsschrift für den Orient*, by Herr Friedrich Müller of Vienna, on the palæography of the Philippine Islands, the inhabitants of the archipelago of Malay descent possess a writing which is going more and more out of use and is being supplanted by the Latin writing introduced with Christianity by the Spanish missionaries. The original writing, which is on the whole in the same form among the various tribes, such as the Tagals, Ilocos, Visayas, Pampangas, is connected first with the writings of the people of the Celebes (Bugis, Macassars), and of Sumatra (Battak, Redschang, Lampong), and the forms point to India as the common origin of all. But whether the writing of the Malay peoples came direct from India, or through the intermediary of another writing; from which Indian alphabet it came, *i.e.* from which province; and at what time,—are questions which various competent scholars have answered in various ways, and which may therefore be regarded as still open. To those who desire to pursue the subject two interesting recent studies may be recommended. One, by Prof. Kern, of Leyden, appears in the well-known Dutch magazine, *Bijdragen tot de Taal-, Land- en Volkenkunde van Nederlandsch-Indië*, vol. iv. No. 10 (1885), which is a critical examination of the whole question; the other, in Spanish, by Señor Pardo de Tavera, is published as a pamphlet, and is entitled "A Contribution to the Study of the Ancient Alphabets of the Philippines." The special value of the latter is that it investigates the subject more thoroughly than any of its predecessors with special relation to the Philippines, and illustrates it by much that is original from the old literature of the archipelago. It is accompanied by plates, containing copies of no less than twelve Philippine alphabets. Nos. 11 and 12, however, appear to be identical, with the exception of being produced with different instruments. No. 11 is probably written with a pen on paper, while No. 12 was probably cut by a knife into wood. Even with this deduction there are still eleven distinct alphabets in this archipelago alone.

THE stone implements, shell heaps, and other prehistoric remains of Japan have already received some attention at the hands of Profs. Milne and Morse, and of Herr von Siebold, an Austrian *savant* in the diplomatic service in Tokio. Until quite recently, although the Japanese prized stone implements and the like, they appear to have done so on account of their peculiar shapes and as curiosities rather than because of their scientific importance. A Japanese gentleman filling a high official position has, however, just published a volume entitled, "Notes on the Ancient Stone Implements of Japan," for a description of the contents of which we are indebted to the *Japan Mail*. Mr. Kanda enjoys high reputation as an antiquarian. His book contains twenty-four plates, to each of which are appended accurate descriptions of the objects delineated, with their names and other details. The plates are not tinted, so they convey no idea of the colours of the originals, many of which are of black serpentine, jade, jasper, amethyst, agate, calcedony, &c. They give the exact shapes and dimensions of all the objects. Mr. Kanda's object is not to ventilate his own opinions, but to furnish

antiquarians abroad with data for comparing the stone implements of Japan with those found elsewhere. In a short treatise of eight pages he describes the beliefs universally current in Japan on the subject of these remains. Dividing stone implements into "chipped" and "polished," he mentions four varieties of the former, which, translating the original Japanese names, he calls arrow-heads, spear-heads, rice-spoons of the mountain gnomes, and pound-stones—the last being really hoe-heads. The three first are known all over Japan, but become more and more numerous as one approaches the north. They are supposed to have been used by the Ainos. Of the "polished" stone implements there are six principal varieties, vulgarly known as thunder-bolts, thunder-clubs, stone daggers, and dagger-heads, *magatama* and *kudatama*, or curve and tube-shaped jewels. The thunder-bolts, so called, are evidently axe-heads; they are found everywhere, but chiefly in the north. The "thunder-clubs" are beautifully ornamented, while their shape and size—occasionally they are found as much as five feet long and five inches in diameter—suggest the idea that they served as insignia of authority rather than as weapons of war. The prehistoric pottery, is Kamloka pottery, from the name of the locality in Northern Japan where it was first discovered. Like the stone implements, it occurs with greater frequency the farther north we go. The general conclusion is thus suggested that the aborigines of Japan were gradually pushed northward by invaders from the south, but where the distinction is to be drawn between the races known as Tsuchigamo, Yezzo, and Aino is a question for future determination. No metal implements have ever been found with this pottery, whereas it is constantly associated with all the stone implements enumerated above. In the ancient tombs, which exist everywhere throughout Japan except in Yezzo, there are unearthed several varieties of stone implements, and with them occur metal implements, together with a species of pottery known as *Giogi* ware, after a priest of that name who came to Japan from Corea in the eighth century, and who is supposed to have introduced the potter's wheel. The name is doubtless improperly applied to the ware found in the ancient tombs, for in court relics now preserved and dating back to the eighth century there is ware incomparably superior to this so-called *Giogi* ware, which should therefore probably be referred to a period much more remote. The stone implements found in these tombs are for the most part of an ornamental character, though some may have served for agricultural purposes. The former include the *magatama*, or "curved jewels" which were used as pendants. Some of them are of nephrite and chrysoprase, minerals never yet found in Japan, so that these ornaments must have been brought over from the Asiatic continent. Mr. Kanda thinks that the ancestors of the present Japanese, when they arrived in Japan, brought with them from their old home metal implements which, not being sufficient for all, were appropriated by the privileged few, the majority of the people going back to stone implements. This curious theory would explain the circumstance that many of the thunder-clubs already mentioned are so beautifully ornamented as to indicate, almost with certainty, the use of metal chisels; but archæologists will probably prefer leaving this circumstance unexplained to adopting so violent an explanation.

WE have received the *Proceedings* of the Windsor and Eton Scientific Society for 1884, with the Society's diary and the presidential addresses since its formation in 1881. One naturally looks in the *Proceedings* of this and similar societies to the local work—the papers with some of the *locus in quo* in them—rather than to the more general papers read and lectures delivered. We find more than one instructive communication on the subject of the old Roman town of Silchester, near Reading; a paper on the trees of Windsor Forest, by Dr. Gee; whilst amongst the papers read during the four years, but not printed, we notice one on some bronze implements found in the Thames near Windsor, on carnivorous plants found in the same neighbourhood, and on recent explorations of a tumulus at Taplow. The Society, which does all its interesting work on a subscription of five shillings from each member, is affiliated with the Albert Institute of Windsor, and was formed in consequence of the success of an exhibition of microscopes and other scientific objects which formed one of the fortnightly entertainments provided by this institute.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus* ♂) from India, presented by Mr. F. J. Edmonds; a Greater Sulphur-crested Cockatoo (*Cacatua galerita*) from Australia, deposited; two Great Kangaroos (*Macropus giganteus* ♂ ♀), eight Silky Bower-birds (*Ptilonorhynchus violaceus*) from New South Wales; two Red Kangaroos (*Macropus rufus* ♂ ♀) from Australia; two Bennett's Wallaby (*Halmaturus bennetti* ♂ ♀) from Tasmania; a Roan Kangaroo (*Macropus erubescens*), two —— Wombats (*Phascolomys* ——) from South Australia, received in exchange; two Sumatran Rhinoceros (*Rhinoceros sumatrensis* ♂ ♀); a Rufous-tailed Pheasant (*Euplocamus erythrophthalmus* ♀) from Malacca; a Bar-tailed Pheasant (*Phasianus reevesi* ♀) from North China; two Peacock Pheasants (*Polyplectron chinquis*) from British Burmah; a Silver Pheasant (*Euplocamus nycthemerus* ♀) from China, a Cocoi Heron (*Ardea cocoi*) from America, purchased; a Bonnet Monkey (*Macacus sinicus*), a Black Lemur (*Lemur macaco*), born in the Gardens.

OUR ASTRONOMICAL COLUMN

ANCIENT OCCULTATIONS OF ALDEBARAN.—In NATURE, vol. xxxi. p. 182, reference was made to an occultation of Aldebaran which Bullialdus found recorded in a Greek manuscript, and which it had been supposed was observed at Athens on March 11, A.D. 509. The extract from the manuscript is given at p. 172 of the well-known work of Bullialdus, "Astronomia Philolaica." The observation is perhaps mentioned in somewhat undecided terms, inasmuch as it is rather implied that after twilight had ended the moon seemed to have occulted the star; nevertheless we have its position described as close to the moon at the time of observation; and further: "Stella quippe apposita erat parti, per quam bisecatur limbus Lunæ illuminatus." If we remember rightly, Street, amongst others, has pointed out that the occultation itself could not have been seen at Athens, but must have been observed at some more eastern station. The following are results of a recent computation in which the moon's place has been determined on the same elements which closely represent the occultations observed in China B.C. 69, February 14, and A.D. 361, March 20, referring to the planets Mars and Venus respectively, as well as other phenomena recorded previous to the fourth century.

A.D. 509, March 11, at 2h. 30m. Paris mean time.

	° ′ ″
Moon's right ascension	48 11 23
,, declination	+12 55 46
Hourly motion in R.A.	30 15
,, ,, Decl.	+7 12

The position of Aldebaran was in R.A. 48° 10′ 16″, Decl. +12° 29′ 29″. The sidereal time at mean noon at Athens was 23h. 22m. 11s. Hence, calculating for Athens, we find the star disappeared at 3h. 7m., and re-appeared at 4h. 37m. local mean time; the sun set at 6h. 6m., so that the occultation occurred in broad daylight, and "post accensas lucernas" there would be a considerable distance between the moon and the star, as seen at Athens.

By way of testing the moon's place here employed, we may examine the circumstances of another occultation of Aldebaran, which Gaubil extracted from the Chinese historical works, and thus describes:—"In the ninth year (period *Yung-ming*), third moon, day *ping-chin*, the moon eclipsed Aldebaran;" this occurs in the records of the "Dynastie des *Tsi* du sud, la cour à Nanking." Gaubil gives the date March 29, A.D. 491 Proceeding as before we have for

A.D. 491, March 29, at 1h. 30m. Paris mean time

Moon's right ascension...		48° 35′ 53″
,, declination		+12 53 1
Hourly motion in R.A.		29·44
,, in Decl.		+7·39

The position of Aldebaran was in R.A. 47° 50′ 44″, Decl. +12° 10′ 15″. The sidereal time at mean noon at Nankin was 0h. 29m. 36s., and, calculating for that place, we find the star disappeared at 9h. 2m. local mean time, and would set at 9h. 14m., so that its altitude at disappearance was only 2°·3. Whence, assuming the accuracy of these computations, it is clear that the occultation could not have been seen as recorded at Nankin, if the moon's place about the epoch to which they refer were sensibly behind that deduced, so as to render possible an observation in twilight at Athens of the occultation of March 11, 509.

This result for the circumstances of disappearance of Aldebaran at Nankin in 491 reminds us of a similar observation made in London on the occultation of the same star, September 14, 1717, probably from the roof of the Royal Society's house in Crane Court, Fleet Street, whence, we are told, on the occasion of the total solar eclipse in 1715 there was a free horizon. "On the 14th of September, in the evening, for the first time the moon returned after a long interval to hide *Palilicium*; and the sky was extraordinarily clear at London, so that the moon and the star were seen to rise in the horizon at the same time; the immersion of *Palilicium* was at 9h. 6m. 20s., the moon not being 3° high, in the very middle, as it were, of the eastern limb, over against the northern part of that small *macula* which Hevelius called *Stagnum Mæridis*, and Ricciolus by his own name . . ."

BARNARD'S COMET.—A new computation of the orbit of this comet, by Mr. Egbert, of the Dudley Observatory, Albany, U.S., confirms that of Dr. Berberich, as regards the close approach which the comet makes to the orbit of Mars. At a true anomaly of 37° 35′, corresponding to heliocentric longitude 343° 52′ (equinox of 1884), the distance is within 0·008, the earth's mean distance from the sun being taken as unity, and a very close approach of the two bodies may have taken place, as before remarked, at the end of the year 1873. Dr. Berberich's period of revolution is 1958·9 days, that of Mr. Egbert 1970·3 days, an increase of only ten days on the latter period would suffice to have brought the comet and planet together in December 1873. The latest observation made by M. Perrotui, at Nice, in November, 1884, has not yet been brought to bear upon the direct calculation of the orbit, though Dr. Berberich's comparison of his elements therewith shows but small difference between calculation and observation. Barnard's comet does not quite attain to the orbit of Jupiter, the distance at aphelion being 0·555.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *APRIL* 12–18

(FOR the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on April 12

Sun rises, 5h. 12m.; souths, 12h. 0m. 41·7s.; sets, 18h. 51m.; decl. on meridian, 8° 51′ N.: Sidereal Time at Sunset, 8h. 15m.

Moon (New on April 15) rises, 4h. 2m.; souths, 9h. 47m.; sets, 15h. 43m.; decl. on meridian, 3° 38′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	5 27	13 7	20 47	18 0 N.
Venus	5 10	11 41	18 12	5 26 N.
Mars	4 55	11 15	17 35	3 13 N.
Jupiter	13 13	20 30	3 47*	14 1 N.
Saturn	7 46	15 52	23 58	21 59 N.

* Indicates that the setting is that of the following day.

Phenomena of Jupiter's Satellites

April	h. m.		April	h. m.	
12	2 1	I. occ. disap.	14	22 43	III. occ. disap.
	23 22	I. tr. ing.	15	2 22	III. occ. reap.
13	1 41	I. tr. egr.		3 13	III. ecl. disap.
	20 29	I. occ. disap.	16	0 0	II. occ. disap.
	23 50	I. ecl. reap.	17	21 2	II. tr. egr.
14	20 9	I. tr. egr.	18	23 36	IV. tr. egr.

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

April	h.	
14	6	Mars in conjunction with and 0° 12′ south of the Moon.
14	20	Venus in conjunction with and 0° 6′ north of the Moon.
16	7	Mercury in conjunction with and 6° 21 north of the Moon.
17	20	Mercury stationary.

GEOGRAPHICAL NOTES

THE Pescadores, which have recently been bombarded and occupied by Admiral Courbet, are a small group of islands lying in the Formosa Channel, about twenty-five miles off the west coast of Formosa. They are attached for administrative purposes to that island, and form one of the six districts into which it is divided. The islands are known to the Chinese as the Panghuting, or district of Panghu, and in Chinese geographical works more than thirty distinct islands are mentioned, but no distinction is made between the inhabited and uninhabited, large and small islands, nor between islands and mere rocks and shoals. The largest of the group is called Panghu, and from it the archipelago has doubtless derived its name. The main island is forty-eight miles in circumference, and the next in size, called Fisher's or West Island, is seventeen. According to the late Admiral Collinson, who surveyed it in 1845, the want of trees, which the Chinese officers accounted for by the violence of the wind and the absence of sheltered valleys, give the islands a barren appearance. Millet is extensively cultivated, and between its rows the ground-nut is planted. In sheltered spots the sweet potato and a few vegetables are grown, but the inhabitants depend mainly on Formosa for vegetables and fruits. Bullocks and poultry were abundant. The population of the two larger islands was stated then to be 5000, and of the whole of the islands 8000. The archipelago contains actually twenty-one inhabited islands, besides several rocks. They extend from 23° 13′ to 23° 48′ N. lat., and from 19° 16′ to 119° 37′ E. long. Their general appearance is flat, the summits of many of the islands being nearly level, and no part of the group being 300 feet above the sea-level. The two larger islands are situated near the centre of the archipelago, forming an extensive and excellent harbour between them. The capital of the whole—Makung or Macon—is situated on the north side of an inlet on the main island. The islands offer shelter in all states of the weather in the dangerous Formosa Channel. The archipelago was seized by the Dutch in 1622, and some remains of their fortifications are still to be seen; but in 1624 they left for Formosa, where they remained till finally driven out by the Chinese pirate Koxinga.

PORT HAMILTON, the English Naval Station in the North Pacific, acquired during the past week, is the name commonly applied to the large Corean island of Quelpart, situated about sixty miles due south of the extreme point of the Corean peninsula, and situated between 33° and 34° N. lat. and 126° and 127° E. long. It has been described at great length by Hamel, the "secretary" of a Dutch vessel wrecked there on its way to Nagasaki in the seventeenth century. Hamel and his companions were kept captive in Corea for thirty-five years, when some of them succeeded in escaping. Hamel's story will be found in Pinkerton and other collections of voyages. During the present century it has also been visited occasionally in search of the crews of shipwrecked vessels. A glance at the map shows its position relatively to Japan, North China, Corea, and the Sea of Japan, and its value as a naval station better than any words could do. It is 150 miles distant from Shanghai, about 100 miles from Nagasaki, and lies in the mouth of the only exit to the south from the Sea of Japan. It is described by Mr. Griffis, a recent historian of Corea, as an oval, rock-bound island covered with innumerable conical mountains, tipped in many instances by extinct volcanic craters, the highest of all being Mount Auckland, or Haura, which is about 6500 feet high. On the top are three extinct craters, within each of which is a lake of pure water, and Corean children are still taught to believe that the three first-created men of the world still dwell on these lofty heights. The whole island is well cultivated; there are a number of towns, three walled cities, but no good harbours. It has long been used as a place of banishment for criminals. The chief industry is the manufacture of straw hats, those from Quelpart being the best in Corea, which is a country of large straw hats. It has been

known from very ancient times, when it formed an independent kingdom. The origin of the great peak of Mount Auckland, which renders the island so conspicuous, is thus given by the inhabitants (we quote from Mr. Griffis): "Clouds and fogs covered the sea, and the earth trembled with a noise of thunder for seven days and seven nights. Finally, the waves opened, and there emerged a mountain more than 1000 feet high, and forty *ri* in circumference. It had neither plants nor trees upon it, and clouds of smoke, widely spread out, covered its summit, which appeared to be composed chiefly of sulphur." The fullest recent account which we possess is one published by a gentleman who visited the place with the French Consul in Shanghai in 1851, to seek for the crew of a vessel, the *Narwhal*, believed to have been wrecked there. The story of the visit was published at the time in an English journal printed in China. The inhabitants are Coreans of the ordinary type; iron appears to abound on the southern coast, and there were ample evidences of much comfort and even wealth among the islanders. Christianity is said to have reached Quelpart through a Corean, who made his way through North China to Hongkong, where he was taught by the missionaries, and who then made his way back to the island.

THE geographical subject proposed this year by the French Academy of Inscriptions for the Prix Bordin is "A Critical Examination of the Geography of Strabo." According to the terms laid down by the Academy, competitors are (1) to give the history of the text of the work; (2) to characterise the language of Strabo with reference to that of contemporary Greek writers, such as Diodorus Siculus and Dionysius of Halicarnassus; (3) to distinguish the information collected by direct observation of places and that drawn by him from his predecessors; (4) to express definite conclusions on his critical method in using various documents. The papers should be in the hands of the Secretary of the Institute not later than December 31, 1886.

THE Hungarian Society of Geography is engaged just now in organising a Magyar expedition for the exploration of the regions about the Urals, and principally of the Baskir country, where the Uralo-Altaic peoples are disappearing. The Society regards it as essential to study tribes which will soon be only a more or less confused recollection. The exploration is to be anthropological, ethnographical, and archæological.

THE Director of the Museum of Ethnography in Paris has just received from the Minister of Public Instruction a fragment of the planking of the canoe in which MM. Crévaux, Bellet, and Ringel were ascending the river when they were murdered on the Tejo-Picolmayo by the Tobas Indians. The Minister sent at the same time a collection of ethnographical water-colour drawings made by Ringel and annotated by Crévaux. These were recovered by M. Bueno, and sent to the French Legation at Rio de Janeiro.

IN the *Bollettino* of the Italian Geographical Society for March an attempt is made to determine the limits of the new "Kingdom of the Congo," as recognised by the late Berlin Conference, and modified by the treaty concluded between the African International Association, and Portugal on February 14. The territory as thus determined would be limited on the west by the Atlantic seaboard from Banana to Yabé (5° 45′ S. lat.), then by the parallel of Yabé to the meridian of Ponta da Lenha; then by this meridian northward to the Chiloango; then by the left bank of this river to its source, and beyond that point by a curved line to the Ntombo-Macata Falls on the Congo, leaving to the French the station of Mboco, but reserving Mucumbi and Manianga; lastly, from the Ntombo-Macata Falls the Congo itself to its confluence with the Bumba beyond the equator, where the boundary running north-west remains still to be determined. The southern frontier follows the Congo from Banana to a point a little above Nokki, the north bank remaining to the Association, the south to Portugal; then from near Nokki the parallel of this place as far as the river Kwango; then this river to about 9° S. lat., and thence a diagonal line across the continent to Lake Bangweolo. Eastwards the boundary coincides with the west coasts of Lakes Bangweolo, Tanganyika, Muta Nzighé, and Albert Nyanza. On the north the frontier will follow the line of water-parting to be hereafter determined between the Congo, Nile, Shari, and Benué (Niger) river basins. Within these limits the new State will have an approximate area of about 1,000,000 square miles and a population of probably 40,000,000, mostly of Bantu speech and Negro or Negroid stock.

THE same number of the *Bollettino* publishes a letter from Count Giacomo di Brazza, dated Brazzaville, October 22, 1884, in which the writer complains that his efforts to complete the triangulation of Stanley Pool were frustrated by the officer of the African Association, a certain Captain S., in charge of the left bank of the pool. To complete the work it was necessary to cross over to that side of the Congo; but the permission to do so was refused by the official in consequence of instructions issued by Colonel de Winton, "that all were to remain on their own side."

ON THE SALINITY OF THE WATER IN THE FIRTH OF FORTH[1]

IT is the purpose of this paper to state the methods employed for examining the salinity and alkalinity of estuary water at the Scottish Marine Station at Granton, and to describe and record six months' observations of the water of the River and Firth of Forth up to December 31, 1884.

(1) *Collection of Water Samples.*—To collect a sample of surface-water from a small boat it is sufficient to wash out the bottle with the water, and then hold it a few inches under the surface until it fills. The temperature of the water is taken by means of an ordinary thermometer in a copper case. On board a larger vessel the same thing may be done, the bottle being attached to a sounding-line and lowered over the side, or, without stopping the vessel, by means of a clean bucket, care being taken to draw the sample forward of the ejection-pipe of the condenser. When brought on board a thermometer is immersed for a minute, and the temperature noted. The water is then bottled, tied down, and labelled.

The water-bottle employed for obtaining samples from any depth beneath the surface consists of a brass basal disk supporting three radiating sheets of brass surmounted by a brass dome, on the top of which there is a ring for the line. The basal plate has an india-rubber ring fixed upon it, and its under surface has two rings for attaching the lead, and a stopcock for running off the water. There is also a brass cylinder, the edge of which rests upon the india-rubber ring when the instrument is closed.

On board the *Medusa*, the steam-yacht of the Marine Station, the water-bottle is attached to the sounding-line, which is wound on a drum worked by a small deck-engine. It has a 7-lb. lead attached to it, the stopcock is closed and a little plug screwed in to prevent the entrance of mud should it strike the bottom. It is then lowered, the slip-cylinder being held in the hand. When the desired depth is reached the slip is let go; it crashes down on the frame and is guided by the brass strips on to the india-rubber ring, on which it presses, and so firmly incloses a sample of water. It has been found necessary to let down one or two cylindrical weights, slipping on the line, after the slip has struck the body, in order to press it firmly down. Repeated trial and continuous use have shown this manner of water-collecting to be satisfactory.

The bottles used for preserving the samples are glass-stoppered, blue glass half-Winchesters, which hold about 1·5 litres. They are packed in boxes, fifteen in each, so as to be carried easily and safely. Each bottle is labelled as it is put aside, with particulars of the date, hour, and temperature.

The temperature below the surface is ascertained by means of the Negretti and Zambra thermometer in the Scottish frame, which was described to this Society in July, 1884 (*Proceedings*, vol. xii. p. 927).

When each sample of water is taken, the following observations are made and recorded:—Date; hour; position by bearings; depth of water;[2] depth from which sample was taken; temperature of the water at that depth; temperature of the air; nature of the weather, wind, and state of sea; state of tide; colour and transparency of the water.[2]

The colour of the water is observed by sinking a disk of iron, painted white, to the depth of a few feet or fathoms, according to circumstances, and noting its colour. The transparency may be very roughly measured by observing the distance to which the disk remains visible.

It is important that the actual notes of all observations be

[1] Abstract of a paper read at the meeting of the Royal Society of Edinburgh, January 5, 1885, by Hugh Robert Mill, B.Sc., F.C.S., Chemist to the Scottish Marine Station, Granton, Edinburgh.

[2] These are sometimes omitted in the case of surface samples.

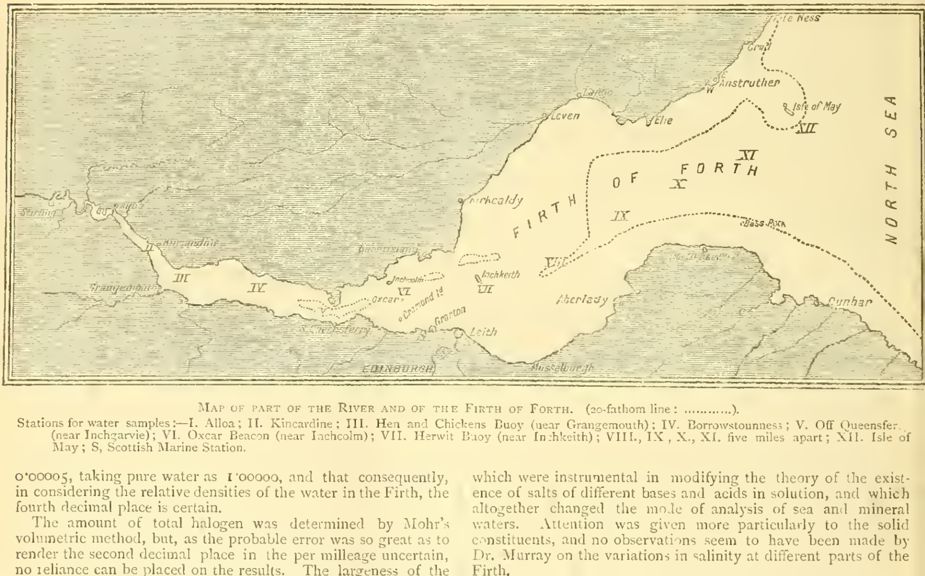
preserved for future reference should uncertainty arise regarding them. There are difficulties in doing this, for it is not easy on a small vessel, when there is any sea on, to keep an ordinary note-book from getting wet. It is most convenient to use cards with memoranda of the observations to be made printed on them, which are kept in a small leather case, and when each card is used, it may be slipped beneath the others, as is done in a date-case. The cards can be conveniently kept in boxes, and may be readily and rapidly referred to at any time.

2. *Determination of the density.*—The density of the samples of water collected in the Firth is determined by means of a very delicate hydrometer of the form used on board the *Challenger*. The hydrometer is made of glass, the tubes for body and stem having been very carefully selected to ensure uniformity of diameter. The instrument has a body of about 5 cm. diameter and 12 cm. long; the stem is nearly the same length, and has a diameter of 3 mm. The process of making and calibrating the hydrometer has been described in great detail by Mr. Buchanan in his *Challenger* report on the specific gravity of ocean water ("*Challenger* Rep. Phys. Chem.," vol. i. pt. ii. pp. 1-4.)

The hydrometer which has been used at the Marine Station is provided with seven movable weights, which can be attached to the top of the instrument, and so increase the weight of the hydrometer from 150·1478 grms. to 155·8390 grms. through thirty-six gradations. The volume of the body and bulb of the instrument is 150·2070 cc. at 0°·3, and its coefficient of expansion is known; the volume of the 100 mm. into which the stem is divided is 0·85 cc., and as it is assumed to be uniform, the volume of each millimetre of the stem is taken as 0·0085.

The density of each water-sample was taken twice, by first using a weight that did not immerse more than the lower third of the stem, then adding another to immerse at least two-thirds. A table giving the volume of the hydrometer at every tenth of a degree Centigrade from 0° to 25° has been drawn up, and from this table the volume of the body at the observed temperature is taken; the volume of the stem immersed is got from another table, which gives the value for each half millimetre from 0 to 100. These added together give the total immersed volume, and, the weight being taken from another table and divided by this volume, gives the density *at the observed temperature*. The mean of the two densities is taken, and reduced from the mean of the two corrected observed temperatures to 15°·56 C. by means of Dittmar's table ("*Chall.* Rep. Phys. Chem.," vol. i. part 1, p. 70).

Advantage was taken of the double determination of each density and of a number of separate experiments to form an idea of the probable error of an individual determination. The result showed that the probable uncertainty is not more than



Map of part of the River and of the Firth of Forth. (20-fathom line: ....).

Stations for water samples:—I. Alloa; II. Kincardine; III. Hen and Chickens Buoy (near Grangemouth); IV. Borrowstounness; V. Off Queensfer.. (near Inchgarvie); VI. Oxcar Beacon (near Inchcolm); VII. Herwit Buoy (near Inchkeith); VIII., IX., X., XI. five miles apart; XII. Isle of May; S, Scottish Marine Station.

0·00005, taking pure water as 1·00000, and that consequently, in considering the relative densities of the water in the Firth, the fourth decimal place is certain.

The amount of total halogen was determined by Mohr's volumetric method, but, as the probable error was so great as to render the second decimal place in the per milleage uncertain, no reliance can be placed on the results. The largeness of the uncertainty is due, in part at least, to the disadvantageous position in which the determinations were made—a floating laboratory where the atmosphere was always more or less laden with saline particles.

The alkalinity was determined by Tornoe's method with standard solutions of hydrochloric acid and of potash.

The quantity represented by an alkalinity is very small, although the number used to express it is large. An alkalinity of 50 means that in a litre—say 1026 grammes—there is 0·05 gramme of carbonic acid as calcium carbonate: that is, a percentage of 0·00487, which, from the inaccuracy of the determinations, might vary from 0·00498 to 0·00476.

Notes of Previous Work on Estuary Water

In 1816 Dr. John Murray read a paper to this Society on the composition of sea-water, the samples which he analysed being taken from the Firth of Forth near Leith. The paper (*Trans.* R.S.E. for 1816) contains results of great theoretical value, which were instrumental in modifying the theory of the existence of salts of different bases and acids in solution, and which altogether changed the mode of analysis of sea and mineral waters. Attention was given more particularly to the solid constituents, and no observations seem to have been made by Dr. Murray on the variations in salinity at different parts of the Firth.

Dr. John Davy published a paper (*Ed. New Phil. Journ.* xxxvi. p. 1) in 1843, on "The Temperature and Specific Gravity of the Water of the Firth of Forth." He examined the temperature and density of the water at the end of Leith pier on eight occasions at intervals of about a month. It was Davy's intention to continue the monthly observations for a number of years, but, as he had to leave Edinburgh, they were stopped. Since no particulars as to how the densities were determined were given, it is impossible to compare them with others observed at a later date.

Dr. Stevenson Macadam investigated the salinity of the Firth of Clyde in 1855 (Brit. Assoc. *Reports*, 1855, ii. 64). He observed the specific gravity at more than fifty places, and determined the total solids and chlorine in each. In subsequent investigations he examined the Firths of Cromarty and Inverness. The results are recorded in the *Proceedings* of this Society for 1866 (*Proc.* Roy. Soc. Ed., p. 5).

Prof. Kyle, of Buenos Ayres, made some observations in

1874 on the River Plate, in the same way as Dr. Macadam on the Clyde. Mr. F. Newman has kindly supplied a translation of Kyle's Spanish pamphlet ("Algunos Datos sobre la Composicion de las Aguas del Rio de la Plata"), and a chart of the Plate, with the water-sampling stations. The results brought out by Prof. Kyle are interesting, but, like the other observers cited above, he neglects to mention whether his specific gravities are reduced to 0°, to 4°, or to 15°·56, or whether water at 0°, 4°, or 15°·56 was taken as unity. It is therefore impossible to consider the results except as purely relative to the estuary in question, and no comparison between the different investigators can be made.

The Cattegat, Skagerrack, Baltic, and north-eastern parts of the North Sea have been made the subject of very careful and prolonged examination by various Danish and German scientific workers. Water-samples have been taken regularly for a number of years at various points along the coast, and from light-houses and light-ships at considerable distances from land. The results of the examination of these samples from 1872 to 1881 are tabulated in conjunction with the meteorological conditions, especially with respect to rainfall, in a recently issued paper by the Commission in Kiel for the scientific investigation of the German seas.[1] The general low densities of these waters, and the variations to which they are subject, make the conditions which obtain there not unlike those in an estuary.

While it is fully realised that it will take years of consecutive observations to thoroughly settle the relations of the fresh and salt water in an estuary, and that many conditions, such as the currents, law of the tides, and rainfall over the area drained by the principal river and its tributaries must be taken into account; it is considered expedient to state the results observed in the six months, from June to December, 1884, on the Firth of Forth. These results are purely preliminary; but as little attention has been given such matters hitherto, they may prove of interest, and may lead to suggestions for improvements in carrying on the work.

The Firth of Forth.—The River Forth rises in the valley between Ben Lomond and Ben Venue, is joined near Stirling by the Teith, and gradually merges into the Firth of Forth, the precise point where the river ends and the Firth begins being a matter which permits of difference of opinion. Probably the best plan is to view the river as ending at Queensferry, but for convenience the term "Firth of Forth" may be applied as describing the river and Firth proper from Alloa to the Isle of May, a distance of fifty-five miles. According to Keith Johnstone the area drained by the Forth is 500 square miles. Few large rivers flow into the Firth. Those of any importance are: on the north side, the *Black Devon*, at Clackmannan; and the *Leven*, at Leven: on the south side there are the *Carron*, at Grangemouth; the *Avon*, a few miles further east; the *Almond*, at Cramond; the *Water of Leith*, at Leith; the *Esk*, at Musselburgh; and the *Tyne*, near Dunbar.

From Alloa to within three miles of Queensferry the depth of the water is under 10 fathoms; there it increases, at first gradually, then at the Bamer Beacon abruptly, to over 30 fathoms, and close to Inchgarvie, to over 40 fathoms. This is the deepest part of the Firth, and the narrowest. The Forth Bridge is in process of construction at this point. A very strong tide runs in the channels on each side of Inchgarvie, and the deep water is confined to a very small area. The 10-fathom stream runs along the northern shore, until off Kirkcaldy, where it widens out in a funnel shape, and approaches the shore on each side. There is a short tract over 10 fathoms to the south of Inchkeith, known as the *Narrow Deep*. Several small depressions of more than 20 fathoms occur between Queensferry and Inchkeith, and a little to the east of that island the 20-fathom area begins as a narrow stream trending northward, and spreading out off Largo. The Isle of May is connected to the mainland of Fife by a submerged plateau rising to less than 20 fathoms from the surface; and, about four miles east of the May, depths beyond 30 fathoms commence.

A line drawn from Aberlady Bay to Largo divides the Firth into two very different halves. To the west of it the slope of the bed is extremely gradual, and the depth slight; to the east of it the shore slopes down abruptly, and the bed of the Firth is, with one or two insignificant exceptions, uniformly over 20 fathoms in depth.

[1] *Vierter Bericht—für die Jahre* 1877 *bis* 1881. Berlin, 1884: "Periodische Schwankungen des Salzgehaltes im Oberflächenwasser in der Ostsee und Nordsee."

Observations on the Surface Salinity in the Firth.—It is assumed that the amount of total salts may be deduced from the density, as if estuary water were ocean water diluted with pure water. This cannot be exactly the case, as the salts carried down by rivers are in quite different proportion to those found in the sea, and before the processes occurring there have had time to produce uniformity of composition—that is, where river-water predominates—the proportion of salts among themselves must vary. Consequently, until exact experiments can be made on this point, the interpretation of estuary densities by ocean-water tables must be taken with reservation, and it is better to view the densities as such, without reducing them to amounts of total salts. To get a preliminary view of the rate of freshening, it was determined in September 1884 to make a monthly trip for collecting water samples from the entire Firth; and on September 18 the *Medusa* proceeded from Inchkeith to Grangemouth for that purpose. Surface samples were taken every five miles, and bottom samples at each alternate station. Observations were made both in going and in returning. The intention to make the complete tour of the Firth in one day had to be relinquished, and the Inchkeith to May section was completed on the 25th. This double trip showed that the densities of the water samples decreased steadily, gradually, and uniformly from the May to Inchkeith, but that the change then became more rapid, the curve resembling a portion of a rectangular hyperbola. The second water sampling trip was on October 7 and 8; the water, beautifully clear and transparent, and of a deep green-blue colour at the May, became light green and less transparent about Inchkeith, and from Inchgarvie onwards it was yellow and very muddy. The results were similar to those of September. The November trip took place on the 10th and 11th; the weather was fine, almost summer-like, and, in consequence of previous heavy rains, all the rivers were in flood. The effect was a marked lowering of the density of the surface water, greatest in the upper reaches of the Firth, but quite perceptible at the Isle of May, which is almost in the open sea. The effect of this "spate" was to reduce the density at Inchgarvie from its mean of 1·02382 to 1·02029; that at the Oxcar Beacon from the mean of 1·02438 to 1·02022; that at Inchkeith from 1·02472 to 1·02403; and those at Stations VIII. and IX. from 1·02505 and 1·02518 to 1·02458 and 1·02508 respectively. The December trip did not take place till the 25th, when my friend Mr. Ritchie was good enough to take charge of the eastern excursion. The day was fine, with a north-easterly breeze and a slight swell. On the 27th the yacht started for Alloa, but the morning, which was hazy, gave place to a day of fog, and it was impossible to proceed beyond Inchgarvie. The 29th and 30th were also misty, and this portion of the trip had very reluctantly to be dispensed with.

The effect of the tide obscures the changes of salinity to a certain extent in these monthly cruises, but, although the data are so few, they are sufficient to show that between Inchkeith and the Isle of May—that is, in the wide and open part of the Firth—the tidal effect is relatively slight and the variations in density very gradual, though perceptible; while from Inchkeith to Alloa the tidal effect increases with every mile, and the rate of change becomes more and more rapid. The following tables (I. and II.) give the figures observed in these consecutive trips:—

TABLE I.—*Density at* 15°·56

1884	I.	II.	III.	IV.	V.	VI.
Sept.	—	—	1·02082	1·02285	1·02444	1·02470
Oct.	1·00160	1·01088	1·01911	1·02272	1·02332	1·02443
Nov.	0·99923	1·00272	1·01419	1·01704	1·01946	1·02022
Dec.	—	—	—	—	1·02351	1·02353

1884	VII.	VIII.	IX.	X.	XI.	XII.
Sept.	1·02499	1·02533	1·02531	1·02527	1·02549	1·02555
Oct.	1·02505	1·02512	1·02547	1·02545	1·02555	1·02558
Nov.	1·02403	1·02458	1·02501	1·02529	—	—
Dec.	1·02454	1·02511	1·02508	1·02545	1·02554	—

TABLE II.—*Alkalinity*

1884	I.	II.	III.	IV.	V.	VI.
Sept.	—	—	—	—	49·1	50·4
Oct.	—	—	—	—	—	—
Nov.	1·2	11·6	31·4	39·2	44·3	45·2
Dec.	—	—	—	—	48·0	49·6

1884	VII.	VIII.	IX.	X.	XI.	XII.
Sept.	49·6	—	—	—	—	—
Oct.	—	—	—	—	—	—
Nov.	48·3	48·6	50·5	49·7	—	—
Dec.	51·2	52·3	51·4	51·7	53·9	—

The mean of the density, &c., at the stations going and returning is given here.

The maximum, minimum, and mean of all the density observations at each station, together with the number of cases which give the mean, are tabulated (Table III.). The temperature observations made on the monthly trips have not been alluded to here; they are intended to form a separate paper.

TABLE III.—*Variations in Density*

Station	Maximum	Minimum	Mean	No. of Obs.
I. Alloa	1·00160	0·99923	1·00042	4
II. Kincardine	1·01521	1·00070	1·00680	4
III. Hen & Chickens buoy	1·02169	1·01084	1·01898	11
IV. Blackness	1·02414	1·01650	1·02087	6
V. Inchgarvie	1·02461	1·01863	1·02303*	11
VI. Oxcar	1·02492	1·01953	1·02355†	10
VII. Inchkeith	1·02526	1·02380	1·02472	13
III.	1·02544	1·02450	1·02505	7
IX.	1·02551	1·02495	1·02518	8
X.	1·02557	1·02417	1·02530	9
XI. Off Fiddra	1·02566	1·02526	1·02547	6
II. May Island	1·02570	1·02443	1·02511	5

* Omitting the day of high flood in the river, mean = 1·02382
† " " " " " = 1·02438

Differences between mean densities:—

I.	II.	III.	IV.	V.	VI.	VII.	VIII.	IX.	X.	XI.	XII.
638	1218	189	216	52	113	33	13	12	17	−36	

Note.—All the densities given are at 15°·56 C.

The change of temperature produces a corresponding change of the density of the water *in situ*, which has important bearings on convection currents, and which must also influence the rate of mixture of sea and river water, especially as the temperature of the river water is in winter usually below that of its maximum density.

An examination of Table III. shows that for maximum and minimum, as well as for mean observed densities, the increase is perfectly continuous until the last station is reached, when the maximum density is only probably greater than that at Station XI., the minimum is certainly less than that at Station VIII., and the mean is less than that at Station IX. It is not easy to find an explanation of this fact, for there is no river nearer than the Tyne at Dunbar, and there are no springs on the Isle of May, the lighthouse keeper being compelled to get all his fresh water carried from Crail. The proximity of the Firth of Tay may possibly account for the observation.

The difference between the density of the surface-water at high and at low tide is by far the greatest in the upper reaches of the Firth, and decreases more and more gradually. Beyond Inchkeith the difference is little noticed, in fact the water is found to be sometimes denser at a lower state of tide. This effect may be due to currents which are not taken account of in this preliminary investigation. The rate of change of density with the tide decreases very rapidly at first. At Kincardine the difference between high and low water is 1 in the second place of decimals, or, calling the density of pure water 10,000, it is 100; at Inchgarvie it is about 15, at Inchkeith 4, and beyond Inchkeith about 1; that is 1 in the fourth decimal place by ordinary notation.

The density of the surface-water was determined almost daily from August to December at the Scottish Marine Station, Granton, but the results were so variable, that dependence cannot be placed upon them as representative of the water in the Firth at that point. The density was always found to be greater at low water, and after some trouble the cause was ascertained. From the station westward for a distance of a mile and a half the shore dries at low water for from quarter to half a mile, and Cramond Island becomes a peninsula, on the west or further side of which the River Almond discharges itself. At high water there is from half to one fathom of water between Cramond Island and the coast, and the river, taking the shorter course, is carried by the ebb tide along the shore, and so reduces the density of the water in the neighbourhood.

As there was considerable time lost in devising and testing a suitable means of collecting samples of bottom water, the number of reliable cases for consideration is small.

It may be generally stated that the part of the Firth east of Inchkeith is the region where the difference between the density of surface and bottom water is least, and that the difference decreases steadily towards the May. Towards Alloa, on the other hand, the differences in the density between surface and bottom water are great, but they are greatly influenced by the tide. Table IV. gives details of nineteen comparisons between bottom and surface water.

At the Hen and Chickens Buoy, near Grangemouth, the depth is only 5½ fathoms, but the salinity is very much greater at the bottom than at the surface. The difference is least observed at low water, but as the flood tide sets in, it appears to increase, and then to fall off again as the ebb commences. The only divergence from this rule noticed was on November 11, when the rivers were all much flooded and the current very rapid. It would appear that these observations confirm the theory that sea water ascends rivers along the bottom under the opposite current of fresh water.

TABLE IV.—*Bottom Water at Hen and Chickens, near Grangemouth* (III.)

Date. 1884	Sample	Tide	Depth, fms.	Density B.	Density S.	Density Dif.	Alkalinity B.	Alkalinity S.	Alkalinity Dif.
June 19	20 & 21	l.w.	2	1·01876	1·01850	26	—	—	—
Oct. 8	183 & 184	2h. fld.	4	1·02041	1·01693	348	—	—	—
Nov. 11	206 & 208	1h. ebb	5½	1·02158	1·01755	403*	44·7	34·3	10·4
"	207 & 209	5h. ebb	5½	1·02040	1·01084	956*	47·4	28·5	16·9
			At Inchgarvie (V.)						
June 19	22 & 24	1h. fld.	25	1·02478	1·02424	54	—	—	—
July 31	41 & 43	5h. ebb	31	1·02455	1·02324	131	—	—	—
Sept. 18	129 & 133	½ ebb	35	1·02448	1·02425	23	56·9	47·9	9·0
Oct. 8	178 & 179	l.w.	40	1·02437	1·02241	196	—	—	—
Nov. 11	200 & 202	h.w.	32	1·02508	1·02029	479*	51·8	46·5	5·3
"	201 & 203	l.w.	35	1·02476	1·01863	613*	45·0	42·1	2·9
Dec. 27	259 & 260	h.w	38½	1·02509	1·02351	158	53·9	48·6	5·3
			At Inchkeith (VII.)						
Sept. 18	119 & 123	¾ ebb	15½	1·02491	1·02481	10	50·4	48·2	2·2
Oct. 7	160 & 161	l.w.	13½	1·02517	1·02519	−2	—	—	—
Oct. 8	174 & 175	¾ ebb	10	1·02501	1·02494	7	—	—	—
Dec. 25	247 & 248	2h. ebb	17	1·02531	1·02470	61	48·6	48·6	0
			At Station IX.						
June 11	13 & 15	5h. ebb	22	1·02424	1·02417	7			
			At Station XI.						
June 4	1 & 3	½ ebb	23	1·02542	1·02528	1			
			At May Island (XII.)						
June 11	16 & 17	2h. fld.	7	1·02532	1·02443	89			
Oct. 7	167 & 168	¾ fld.	9	1·02562	1·02547	15			

* Rivers in flood.

Speaking roughly, it appears that waters having an alkalinity under 40 (that is, in which there is less than 0·04 grammes of carbonic acid as carbonate of lime per litre) have a density under 1·0200, alkalinities under 25 correspond to densities under 1·0100. The only strikingly anomalous case is that of sample 189, a bottom water from off Alloa, when the river was low and very dirty. The density was 1·00146, the alkalinity 47·9, which usually corresponds to a density of 1·024. The presence of sewage in the river might account for this observation to some extent, but more probably it was due to the presence of particles of calcium carbonate. With an alkalinity between 40 and 50 water has a density between 1·024 and 1·025 as a general rule, and when the alkalinity is over 50 the density is almost invariably over 1·025.

On account of the absence of data for deducing the total salts of estuary water from the density, we cannot reduce the alkalinity to percentage of total salts, and, consequently, it is impossible to form a correct idea of the difference between bottom and surface alkalinities, as this difference may be entirely due to the different salinity of the water.

Arrangements have been made for continuing and greatly extending observations on the salinity of the Firth of Forth. Samples of water will be taken by trustworthy observers at high and low water at different points on the Firth, and water-sampling trips, both from Alloa to the May and across the Firth from north to south at various places, will be carried on regularly.

Throughout this paper the density of the water is given as reduced to 15°·56 C. (60° F.). It is *specific gravity* at 15°·56 referred to pure water at 4° C. as unity.

The water-sampling stations and the principal contour lines of depth are shown in the chart of the Firth of Forth (Fig. 1).

THE PEARL FISHERIES OF TAHITI

A RECENT issue of the *Journal Officiel* contains a lengthy report by M. Bouchon-Brandely, Secretary of the College of France, who was sent by the Ministry of Marine and the Colonies on a mission to Tahiti to study questions relating to oyster-culture there. The principal product of what M. Brandely, with "the summer isles of Eden" fresh in his mind, calls "*notre belle et si poétique colonie de Taïti*," is mother-of-pearl. All its trade is due solely to this article, which for a century has regularly attracted vessels to the islands which compose the archipelagoes of Tuamotu, Gambier, and Tubuai. The mother of-pearl which is employed in industry, and especially in French industry, is furnished by various kinds of shells, the most estimated, variegated, and beautiful of which are those of the pearl oyster. There are two kinds of pearl oysters—one, known under the name of pintadine (*Meleagrina margaretifera*), is found in China, India, the Red Sea, the Comoro islands, North-Eastern Australia, the Gulf of Mexico, and especially in the Tuamotu and Gambier archipelagoes; the other, more commonly called the pearl oyster (*Meleagrina radiata*), comes from India, the China seas, the Antilles, the Red Sea, and Northern Australia. The shell of the former is harder, more tinted, more transparent, and reaches greater dimensions than the latter. Some have been found which have measured thirty centimetres in diameter and weighed more than ten kilogrammes, while the *Meleagrina radiata* rarely exceeds ten centimetres at the most, and never weighs as much as 150 grammes. Both varieties supply pearls, those of one kind being at one time more favoured, at another time those of the other. This depends on fashion; but, on the whole, those found in the great pintadine are more beautiful, and the colour more transparent, than those of its congener. The amount of the trade from Tahiti in pearls cannot be stated with accuracy, as there is much clandestine traffic, but M. Brandely puts it down approximately at 300,000 francs, England, Germany, and the United States being the chief markets for the fine pearls. The great pintadine is found in great abundance in the Tuamotu and Gambier islands. The situation there is very favourable to them; in the clear and limpid waters of the lagoons they have full freedom for development, and are undisturbed by storms. Mother-of-pearl is found in almost every one of the eighty islands which form the archipelagoes Tuamotu and Gambier. These belong to France, having been annexed at the same time as Tahiti and Moorea, and have a population of about 5000 people, all belonging to the Maori race. M. Brandely gives an interesting description of these little-known islands and people. The latter appear to hover always on the brink of starvation, as the islands, which are composed mainly of coral-sand, produce hardly anything of a vegetable nature. While the neighbouring Society islanders have everything without labour and in abundance, the unfortunate inhabitant of Tuamotu is forced to support existence with cocoa-nuts, almost the only fruit-trees which will grow on the sandy beach, with fish and shell-fish which are poisonous for several months of the year, and often they have to kill their dogs for want of other animal food. There are no birds, except the usual sea-birds; no quadrupeds, except those brought by man; no food resources necessary to European life, except what is brought by ships. Although the people are gentle and hospitable, they practise cannibalism, and M. Brandely suggests that it is pitiless hunger alone which has driven them into this horrible custom. These miserable people are the chief pearl-divers of the Pacific; indeed it is their only industry, and women and even children take part in it. There is at Anaa, says the writer, a woman who will go down twenty-five fathoms, and remain under water for three minutes. Nor was she an exception. The dangers of the work are great, for the depths of the lagoons are infested by sharks, against which the divers, being unable to escape, are forced to wage battle, in which life is the stake. No year passes without some disaster from sharks, and when one happens all the divers are seized with terror, and the fishing is stopped for a time. But gradually the imperious wants of life drive them back to the sea again, for mother-of-pearl is the current coin of the Tuamotu. With it he buys the rags which cover him, the little bread and flour which complete his food, and alcohol, "that fatal present of civilisation," for which he exhibits a pronounced passion. Twenty or thirty years ago the trade in mother-of-pearl in the Tuamotu archipelago was very profitable for those engaged in it. For a valueless piece of cloth, a few handfuls of flour, or some rum, the trader got half a ton of mother-of-pearl worth one or two thousand francs, or even fine pearls of which the natives did not know the value. The archipelagoes were frequented by vessels of all nationalities; mother-of-pearl was abundant, and pearls were less rare than they are now. The number of trading-ships increased; there was competition amongst them, and consequently a higher price to the natives, who fished to meet the new demand with improvident ardour. The consequence is that the lagoons are less productive, and that even the most fertile give manifest signs of exhaustion. The prospect of having the inhabitants of Tuamotu thrown on its hands in a state of helpless destitution, as well as of the disappearance of the principal article of the trade of Tahiti, and an important source of revenue to the colony, alarmed the Colonial administration, and the Ministry of Marine and the Colonies in Paris. Accordingly, M. Brandely was selected to study the whole subject on the spot. The points to which he was instructed to direct especial attention were these: (1) The actual state of the lagoons which produce oysters; are they beginning to be impoverished, and if so what is the cause, and what the remedy? (2) Would it be possible to create at Tuamotu, Gambier, Tahiti, and Moorea, for the cultivation of mother-of-pearl, an industry analogous to that existing in France for edible oysters? Would it be possible by this means to supply the natives of Tuamotu with continuous, fixed, remunerative labour which would render them independent, and remove them from the shameless cupidity of the traders? Could they not be spared the hardships and dangers resulting from the continued practice of diving, and be turned to more fixed sedentary modes of life, by which they might be raised gradually in the social scale? (3) Should the pearl fishing in the archipelagoes be regulated, and, if so, what should be the bases of such regulations? It was on the mixed economical and philanthropic mission here indicated that M. Brandely went to Tahiti in February last. The statistics did not show any decline in the production of mother-of-pearl, but a careful study on the spot showed that this was due to the great amount of the clandestine traffic, and that the lagoons were growing less productive day by day, that beautiful mother-of-pearl was becoming rarer, and in order now a-days to get oysters of a marketable size, the divers are forced to go to ever greater depths. M. Brandely recommends prompt and vigorous measures be taken at once, as the lagoons of Tuamotu will soon be ruined for ever. The partial steps already adopted have been useless. The total prohibition of fishing in some of the islands for several years has failed, because it has been found that the pintadine is hermaphrodite, and not, as formerly was believed, unisexual. The cause of the impoverishment of the lagoons is excessive fishing, and nothing else. He thinks that it is possible to create in Tuamotu, Gambier, Tahiti, and Moorea a rational and methodical cultivation of mother-of-pearl oysters, analogous to that existing with regard to edible oysters on the French coasts, and to constitute for the profit of the colony an industrial monopoly which no other country can dispute, for nowhere else can such favourable conditions be met with.

SOCIETIES AND ACADEMIES

LONDON

Royal Society, March 26.—"On the Peculiar Behaviour of Glow Lamps when raised to High Incandescence." By W. H. Preece, F.R.S.

The experiments described had for their object the investigation of a phenomenon observed by Mr. Edison, who brought it to the author's notice last autumn. Between the limbs of an incandescent filament of a glow-lamp a thin, narrow platinum plate being fixed with an independent wire connection, and a sensitive galvanometer being placed in circuit between the filament and the platinum, a derived current is observed to pass through the galvanometer and through the rarefied space at the bottom of the limb when the main current is increased to a certain strength and the filament reaches a certain degree of incandescence, the strength of the derived current increasing with the increased brilliancy of the glowing filament. In the author's investigations Mr. Edison had made other lamps, in

which the centre conducting plate was of copper, iron, and carbon respectively; but the general effects were practically the same as when platinum was used. The currents (from Faure-Sellon-Volckmar cells) were increased gradually, the effects of each increase being carefully noted. The nature and resistance of the rarified space in the shunt-circuit had to be ascertained. Certain increments in the current were followed by a diffused blue effect in the globe, more or less intense, accompanied in each instance by a marked fall in the resistance of the shunt—pointing to an intimate connection between the two phenomena. The strength of the shunt-current when the faint blue tinge appeared was: with carbon, 3·42; with iron, 3·85; and with copper, 3·80 milliamperes. No perceptible difference in the results was observable with lamps in which the centre plate was a fine wire or a very broad surface, nor when the plates were doubled. That the effect was due primarily to the "Crooke's bombardment," or the projection of molecules in right lines from the carbon filament on to the metal plate was confirmed by the following experiments:—Lamps were constructed varying the position of the plate. In one the plate, was fixed at the end of a tube having a portion of the filament exposed to the plate; in this case, with an E.M.F. of 108 volts in the main circuit, the blue effect entered the tube. In another lamp the tube was so constructed that no portion of the filament was opposed by right lines to the metal plate; with 112 volts the blue in the globe became very marked; with 120 volts the bulb was hot, the tube cool. Another lamp was constructed with three branches at right angles to each other, and each metal plate taken in succession; no result was obtained, no current being evident in either section. All the experiments went to show that, when once the blue effect appeared, destruction was only a question of time. Hence this blue effect is an indication of the advent of disintegration, and a very useful warning of danger ahead. Whenever the incandescence of the filament is raised beyond a certain limit, the interior of the glass envelope is blackened by a layer of carbon which has been deposited by a Crooke's bombardment effect.

It was evident from the observations that the Edison effect is due to the formation of an arc between the carbon filament and the metal plate fixed in the vacuous bulb, and that this arc is due to the projection of the carbon particle in right lines across the vacuous space. Its presence is detrimental to the life of the lamp, and as its appearance is contemporaneous with the blue effect, the latter is a warning of the approach of a critical point and a sure indication that the E.M.F. is dangerously high. It is also clear that, as the Edison effect is only evident when we are "among the breakers," it is not available for practically regulating the conditions of electric light currents as its ingenious discoverer originally proposed.

Mathematical Society, April 2.—J. W. L. Glaisher, F.R.S., President, in the chair.—Dr. R. Stawell Ball, F.R.S., Astronomer Royal, Ireland, and Baboo Basu, of Bhowanipore, were elected Members.—The following communications were made:—New relations between bipartite functions and determinants, with a proof of Cayley's theorem in matrices, by Dr. T. Muir.—On eliminants, and associated roots, by E. B. Elliott.—On five properties of certain solutions of a differential equation of the second order, by Dr. Routh, F.R.S.—On the arguments of points on a surface, by R. A. Roberts.—On congruences of the third order and class, by Dr. Hirst, F.R.S.

Geological Society, March 11.—Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., President, in the chair.—William Lester and Thomas Stewart were elected Fellows of the Society.—The following communications were read:—The granitic and schistose rocks of Donegal and some other parts of Ireland, by C. Callaway, D.Sc., F.G.S. The author first recalled attention to the current theories on the nature of the Donegal granitic rock, one which described it as a highly metamorphosed portion of a sedimentary series, another which regarded it as a mass of Laurentian gneiss. In his view, however, it was a true igneous granite, posterior in age to the associated schists. In six districts examined it was intrusive and sent out veins. The apparent interstratification with bedded rocks was explained as a series of comparatively regular intrusions. Where the granite was seen in contact with limestone, the latter contained garnets and other accessory minerals. No gradation could be discovered between the granite and any other rock, the junctions (even in the case of small fragments of schist immersed in granite) being well marked. The granite was distinctly foliated. In some localities there was merely a linear arrangement of the mica; but near the western margin of the granite promontory there was a striping of light and dark bands, the colour of the latter being due to the abundance of black mica. The gneissic structure was attributed to lateral pressure, the existence of which in the associated strata was seen in the conversion of grits into schist-like rocks, in the production of cleavage in beds of coarse materials, in the crushed condition of some masses, in the overthrow of folds, and in the production of planes of thrust. The direction of the pressure was perpendicular to the planes of foliation in the granite. The schistose rocks of the region were divided into two groups. The *Lough Foyle series* consisted of quartzites, quartzose grits with a mineralised matrix, slaty-looking schists, fine-grained satiny schists, black phyllites, and crystalline limestones and dolomites. The semicrystalline condition of most of these rocks was characteristic. This series was well seen at Londonderry and on Lough Foyle, and formed a broad band striking to the south-west. These rocks were compared with similar types in the Hill of Howth (north of Dublin), near Aughrim (Co. Wicklow), and south of Wexford. The Leinster semicrystalline masses were quite unlike the Wicklow Cambrians, and bore a strong resemblance to the slaty series of Anglesey. They were lithologically intermediate between the Donegal and Anglesey groups, and from a comparison of all these areas the author referred the Lough Foyle series, with some confidence, to the Pebidian system. The prolongation of the Lough Foyle rocks into the Grampian region was well known, and Ireland thus served to connect some parts of the Scottish highlands with South Britain. The author was not prepared to correlate this Donegal series with any American group, but the lithological affinities were rather with the Taconian that with the Huronian. The *Kilmacrenan series*, in which the granite is intrusive, was described as crystalline, and older than the Lough Foyle group. It was mainly made up of micaceous, quartzose, hornblendic, and hydromagnesian schists, quartzites, and crystalline limestones. There were no indications in these rocks of a metamorphism progressive in the direction of the granite. This series was lithologically similar to the Montalban system. Fifty-five microscopic slides of Donegal and Leinster rocks had been examined by Prof. Bonney, whose observations confirmed those of the author both as regards the nature and relations of the granite and the general characters and state of crystallisation of the two schistose groups.—On hollow spherulites and their occurrence in ancient British lavas, by Grenville A. J. Cole, F.G.S.

Edinburgh

Royal Society, March 2.—Robert Grey, Vice-President, in the chair.—At the request of the Society's Council, Dr. A. Geikie, Director-General of the Geological Survey, gave an address on the recent progress of the Survey. He indicated what would be the future work of the Survey.

March 16.—Thomas Stevenson, M.I.C.E., President, in the chair.—Prof. Tait called attention to anticipations of the kinetic theory, and of synchronism, which occur in a tract, "De Potentiâ Restitutivâ," published by Hooke in 1678.—Prof. Crum Brown read a paper on the hexagonal system in crystallography. The forms of the uniaxial systems may be regarded as derived from forms or parts of forms or combinations of the regular system by uniform expansion or contraction in a direction parallel to the axis of the uniaxial system, *i.e.* normal to a face of the cube for the tetragonal, and normal to a face of the octahedron for the hexagonal system. Faces, therefore, which are, in the regular form or combination, at right angles to or parallel to such axis, retain their relative angular position unchanged in the uniaxial form or combination, and can be represented by means of indices referring to the rectangular axes of the regular system, whatever be the amount of the deformation (expansion or contraction). These faces are prism faces, parallel to the axis, and basal faces at right angles to it. All other faces have their angular position affected by the deformation. These other faces are pyramid faces. Each pyramid face lies between, and in the same zone with, a prism face and a basal face. It may, therefore, be represented by the symbol $as + \frac{1}{\rho}bt$, where s and t are the symbols of the prism face and the basal face respectively, a and b are small whole numbers, and ρ is the ratio of the length of a line parallel to the axis after, to the length of the line before deformation. We may put $\frac{b}{\rho} = n$,

when this becomes, for the tetragonal system $(h k 0) + \frac{1}{\rho} n (001)$, which is $\left(h k \frac{n}{\rho}\right)$ the Miller symbol for a pyramid face in this system, with the ratio of the parameter of z to that of x or y, expressed by ρ. In the hexagonal system the symbol $s + \frac{1}{\rho} n t$ takes the form $(h k l) + \frac{1}{\rho} n (111)$, where $h + k + l = 0$. We may leave ρ understood, as it is constant for the same substance and same temperature, and write this in the contracted forms $(h k l, n)$. This gives $h + \frac{n}{\rho}$, $k + \frac{n}{\rho}$, $l + \frac{n}{\rho}$, as the coefficients of x, y, and z in the equation of the face referred to the rectangular axes of the regular system. These axes are, of course, not crystallographic axes of the hexagonal system, but some advantages arise from their use. They are rectangular, and therefore the ordinary formulæ of solid-geometry can be used; the symbol of the general form $(h k l, n)$, where h k and l are free to change places and change sign together, and n changes sign independently, gives a clear oversight of all the faces of the holohedral form, and enables us to derive from the symbol the various kinds of hemihedry.—In a note on the effect of temperature on the compressibility of water, Prof. Tait showed that the minimum compressibility temperature of water appears to rise with increase of pressure.—Dr. A. B. Griffiths' paper on chemico-physiological investigations on the cephalopod liver and its identity as a true pancreas, was read by Mr. Hoyle.

Paris

Academy of Sciences, March 30.—M. Bouley, President, in the chair.—Experiments connected with the phenomena occurring within the sphere of organic life during epileptic fits, by M. Vulpian. The effects of epileptic attacks artificially produced on the dog were found to agree substantially with those observed in human patients subject to ordinary affections of this class.—A reply to the remarks of M. Troost on the objections advanced against his experiments with the hydrate of chloral, by M. Friedel.—Provisional elements of Borrelly's new planet 246, determined at Toulouse from observations taken at Marseilles and Berlin, by M. Andoyer.—Observations of the same planet made at the Paris Observatory (equatorial of the West Tower), by M. G. Bigourdan.—Latitudinal distribution of the solar phenomena (spots, faculæ, eruptions, and protuberances) observed during the year 1884, by M. P. Tacchini. From the observations here tabulated the author concludes that last year the phenomena were more numerous in the southern hemisphere of the sun, where protuberances occurred frequently even near the pole. The spots, faculæ, and eruptions were numerous, especially in a wide zone stretching north and south of the equator, whereas in preceding years a notable diminution had been observed close to the equator itself.—A geometrical presentation of the three constants relative to the great mirror M of the sextant, by M. Gruey.—A method of measuring the double stars by means of the spectroscope, by M. Ch. V. Zenger.—On an apparatus intended to regulate the curvature of the surfaces and the refraction of lenses (four illustrations), by M. L. Laurent. This apparatus is described as a focometer of great precision, generally applicable to all curved surfaces, in ordinary cases showing at a glance and without preparation the *quality* of any optical system.—Remarks on the actinometric observations made during the year 1884 at the Observatory of the Montpellier School of Agriculture, by M. A. Crova.—Heat of combustion of the Ronchamp coal, by M. Scheurer-Kestner.—On the formation of the hydrocarbonate of magnesia (hydromagnesite), by M. R. Engel. In this paper the author gives the results of experiments made for the purpose of determining the causes of the formation of hydromagnesite in the precipitation of a soluble salt of magnesia by alkaline carbonates.—Experiments on the reduction of mannite ($C_6H_8(OH)_6$) by means of formic acid, by M. C. Friedel.—On the formation of the kreatines and kreatinines: a new kreatinine, α-ethylamidopropionocyamidine, by M. E. Duvillier.—On the simultaneous contractions of antagonistic muscles, by M. Beaunis.—On the pelagic fauna of the Baltic Sea and Gulf of Finland, by MM. G. Pouchet and J. de Guerne. From specimens of crustaceans (*Cyclops quadricornis*, *Daphnella brachyura*, *Daphnia quadrangula*, &c.) fished up last year in the Gulf of Finland, the authors conclude that the pelagic fauna of that slightly brackish sea resembles that of the great European lakes, while the central basin of the Baltic offers well-marked transitional forms between fresh-water and marine animals.—On the existence of limestone at Fusulines in the Morvan geological area, by M. Stan. Meunier.—On some crystals of celestine (sulphate of strontian) discovered near Grauchet (Tarn), by M. A. Caraven-Cachin.

Berlin

Physiological Society, February 27.—Prof. Busch laid before the Society two preparations illustrative of his investigations into the laws of ossification. The one preparation was of the inferior maxilla of a dog, in which, when the animal was from three to four months old, two pairs of precisely similar grains of shot were inserted, as fixed marks, into holes bored by a gimlet of the same diameter. In order that such marks might be really fixed points from which the process of growth could be studied, it was necessary that the pieces of metal inserted into the osseous tissue should not project beyond the surface of the bone, nor, on the other hand, should they touch on other organs by the growth of which they would be liable to be displaced. In the inferior maxilla of a dog Prof. Busch had made four marks, two on each side, at distances of several centimetres, and then, with an exact pair of calipers, he measured the distances of the four grains of shot from each other. The wounds soon healed, the dog did not seem to suffer the least inconvenience, and after 112 days was killed. The examination of the lower jaw now showed that of the four grains there were only three still remaining, the fourth not being discoverable. The two placed on one side of the lower jaw, in front and behind, showed exactly the same distance from each other as at the beginning of the experiment. The distance of one grain on one side from the corresponding grain on the other had on the other hand grown greater, while the length of the whole lower jaw from the posterior angle to the anterior end had throughout the period in question undergone an increase of about five centimetres. From these results Prof. Busch inferred that the increase in length of the lower maxilla was not due to interstitial growth but to apposition. The second preparation had for its object to ascertain facts regarding the growth of the epiphyses of the long bones whether it proceeded from the terminal line between epiphysis and diaphysis, from the epiphysal line, or from the articular cartilage. For this purpose steel pins, 1 centimetre long, were inserted into previously bored holes, one pin close under the epiphysal line of the tibia, a second in the epiphysis of the tibia, a third in the epiphysis of the femur, and a fourth close above the epiphysal line of the femur. The point of the gimlet was broken off during the operation, and served as a fifth mark. The question as to the mode by which the epiphyses grew was to be decided by the eventual change in the distance between mark 2 and mark 3. The experiment in this case likewise was carried out on a big dog of three months old, which was killed 119 days after the operation. The examination of the marks then showed that mark 1 was removed several centimetres lower down, lying horizontally under the periosteum. Mark 2 lay apparently unchanged at its original spot; mark 3 was shifted a large piece upwards, and lay horizontally under the periosteum of the diaphysis. As a result of the operation, therefore, instead of under the epiphysal line, it was inserted above that line into the diaphysis; mark 4 was not to be found; mark 5, the broken-off gimlet-point, lay far up on the posterior edge of the diaphysis. As to the growth of the epiphysis, the experiment had therefore no significance, seeing that mark 3 was not inserted into the epiphysis of the femur. It showed, however, indisputably that the diaphyses grow by apposition from the epiphysal line, and that in proportion as the parts retired from this line, they became from resorption thinner and slenderer. In the discussion on this communication, Prof. Wolff stated that he had performed a great number of experiments on the lower jaws of quite young rabbits, which, contrary to the results obtained by Prof. Busch, clearly demonstrated the interstitial growth of the bone in question. After he had quite concluded these experiments, he would lay the results before the Society.—Prof. Ehrlich made a communication on physiologically important results he had obtained from his investigations into the susceptibility of the different tissues to colouring matters. If colouring solutions—in particular methylic blue—were injected into living animals and then, with the utmost expedition, particular tissues were examined, interesting reactions of the living tissue under the colouring materials would be perceived, which, in spite of their rapid evanescence, revealed important facts which by other methods were in part wholly unascertainable, in part to be ascertained only with difficulty.

After the injection of methylic blue, Prof. Ehrlich found in the submucous tissue of the tongue very numerous fibres and fibrous reticula coloured intensely blue which sent processes to the epithelial formations, and it was easy to determine that these fibres were the axis cylinders of the sensory nerves. These blue-tinged axis cylinders were found very numerously in the gustatory cuplets, at the basis of which they formed a quite narrow reticula network, whence, then, single fibres ending in knots proceeded anteriorly to the ciliated cells. Network of blue fibres were found very copiously and closely in the cornea. The iris likewise showed blue plexuses, particularly on the anterior side; on the posterior side only long cancellated reticula were observed. In the muscles, on the other hand, were found only detached blue fibres, the ending of which in the muscle fibre could not be established. The axis cylinders of the motory nerves were, according to this experiment, not coloured by methylic blue during life; it was only the sensory nerves which reacted to the colouring matter. The vessels, arteries, capillaries, and veins were surrounded by blue plexuses. It could not, however, be decided whether the blue fibres proceeded to the smooth muscle cells. In the retina the nervous layer showed no blue colouring. In the ganglion layer, on the other hand, cells richly charged with blue, and having numerous branching processes, were found, which, too, were in communication with the processes of neighbouring cells. In the mixed nerve stems and in the roots of the nerves no blue fibres were found. The central ends, on the other hand, showed a decided methylic blue reaction, as did also the peripherical ends of the sensory nerves. In the brain blue fibres were found only rarely, but were very abundant in the medulla oblongata, while they were wanting, again, in the spinal marrow, and from these results it appears that the colouring of living organs with methylic blue was a very important means towards observing the endings of sensory nerves in them. It must, however, be borne in mind, that the examination had to be prosecuted very rapidly after the colouring process, because, in living tissue, the colouring material got very quickly—in the course of a few minutes—lost by diffusion, and the colouring of the axis cylinders disappeared.—Dr. Benda laid before the Society several preparations sent by Prof. Adamkiewicz, of Cracau, and gave an explanation of them. After colouring with saffranine, Prof. Adamkiewicz found, in transverse sections of nerve fibres and cords of the spinal marrow within Schwann's sheaths, yellow to brown coloured crescents, which were sections of peculiar fusiform cells, and in the opinion of Prof. Adamkiewicz represented hitherto unknown parietal cells, lying within the nerve fibres, distinguished by their saffranine reaction.

Meteorological Society, March 3.—Dr. Hellmann spoke on the rainfall of Germany. After a short reference to the rain-maps of Germany, hitherto published, which had been in some degree prepared from insufficient material and according to inadequate methods, he set forth the points of view which had determined the arrangement of sixty new rain-stations. By grouping and comparing the new annual observations with those of neighbouring stations, which ranged over a long series of years, he was now in a position to draw a number of important conclusions. He was able to establish, for example, that the eastern part of North Germany, and, in particular, the right bank of the Oder, was not, as had hitherto been supposed, a dry district, at least not over its whole area, seeing that there were several stations within that section showing moderate amounts of rain. It was further ascertained that the views formerly prevalent respecting the rainfall in mountainous regions were not correct, each mountain chain not having been considered separately when inductions were made from the data hitherto accumulated, in which other essential factors came to be mixed up with that of the elevation and vitiated the result. In regard to the yearly distribution of rain, Dr. Hellmann's investigations showed that the great North German plain was embraced within the region of the summer rains; that the curve of rain-quantity and rain-frequency sank from January to April, reaching its minimum in that period, whence it rapidly rose to its maximum, which was attained in the summer months, and then sank slowly to its winter values. The maximum of rainfall in the furthest east occurred in June; immediately to the west in July; still more to the west in August; in Sleswick, later still; and in Heligoland, not till November. A closer examination of the rain-curve in North Germany showed that it consisted of two maxima, with a depression of greater dryness occurring in July. A similar double maximum was likewise found in South Germany and in North-West Germany. The first and greater rain maximum occurred with the recurrence of cold in June, and, altogether, the curve of temperature in North Germany showed a perfectly corresponding, inverse course with that of the rain-curve. The mountains of Germany—the Sudetic Mountains, the Taunus, the Harz, the Thuringian Forest—which were all separately investigated in respect of their rainfall—showed an inverse course in the yearly rain-curve as compared with that of the plain. In the mountains, the maximum of rainfall occurred in winter, whence the curve sank in spring, then rose to a small secondary maximum in summer, sank thereafter, and finally rose to its year's maximum in winter. In respect of the absolute rain maxima the observations hitherto made showed that for Germany the month's maximum amounted to about 9·45 inches, and that the greatest daily rainfall amounted for the plain to about 5·91 inches, and for the mountains to from 7·88 to 9·45 inches. The greatest hourly rainfall hitherto observed was 2·96 inches. Dr. Hellmann exhibited a self-registering rain-gauge by Hottinger, and explained its construction.—Dr. Kremser described an ascent of the Schneekoppe made by him on January 3 and 4, 1885, and submitted some meteorological observations taken by him on that occasion. On the height of the ridge he had clear sunshine over head, while the mountains under him lay enveloped in fog, the contour of which he was thus in a position to observe. In the Riesengrund, into which the sun shone clearly, he saw a huge pillar of fog, the upper end of which was curved into a whirling shape, resembling the column of smoke in an ascending air-current, as described in Herr Vettin's experiment (*vide* NATURE, vol. xxxi. p. 284). On the Schneekoppe he saw the brown-red ring around the sun in a state of remarkable completeness. About 10° around the sun was a brilliantly white space, which passed through yellow and yellow-brown into the copper-coloured ring, 6½° broad. At the point where it touched the horizon the two limbs showed different tints. Before sunrise the moon was densely surrounded by a violet halo, which extended to about as far as 18° from the moon, and gradually passed into the dark-blue sky. The observer stationed on the Schneekoppe related that he likewise had often, for now nearly a year, seen the violet halo around the moon. Lastly, it was to be stated that, like all other exposed objects, the telegraph poles were covered with immense masses of hoar-frost, so that they showed a diameter reaching to 1 m., and the rain-gauges were also so heavily covered with the hoar-frost as to be practically useless.

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THURSDAY, APRIL 16, 1885

A SCIENTIFIC UNIVERSITY

ENGLAND is but just beginning to feel the wave of progress in the question of University organisation that has been sweeping over the rest of the world. University reform as understood in England means a rather fitful movement from within to lift the teaching and methods of the older Universities a little out of the mediævalism that has been settling down upon them. The true University reform has meantime been going on outside in the spread of scientific teaching far away from the quiet collegiate quadrangles, in the establishment of new Universities and University Colleges in the centres of provincial life. It is very hard to make an Englishman believe that there is any subject in which he is not leading the progress of the world. Yet let him look at Germany, at France, at America, and consider what is being done abroad, before he passes his complacent comment on the feeble reforms at home. Let him look at the City of Berlin with its 1,123,000 inhabitants, its teaching University with 6000 students; and then turn to the City of London with its 4,000,000 inhabitants, without a teaching University at all, and having some 2000 students in all under training at its two best educational establishments. The contrast does not stop here, as any person acquainted with the University systems of Europe knows only too well. The fact is that England is wofully behind the rest of the world in the organisation of the higher scientific education. Its Government is absolutely indifferent to the most crying needs in this direction. What does the British Government do for the higher scientific teaching, or for the promotion of the reorganisation of our existing Universities on the modern scientific basis? An annual grant of a few thousands to the South Kensington Normal School, a subsidy of about 25,000*l.* a year to the Scottish Universities, and one of about 12,500*l.* a year to the Welsh University Colleges, whereof perhaps one-half goes to the promotion of science, represent the net result. True a Government some fifty years ago founded the Examining Board, miscalled the University of London, and another Government, some fifteen years ago, gave 90,000*l.* to help the University of Glasgow to complete its buildings. But for the University movement throughout England, such as it is to-day, England owes nothing to one single statesman or Government; it is due to individual and local effort, aided it is true, but on the most minute scale, by the action of one or two of the more liberal corporate bodies. It is well, then, that Englishmen should have the opportunity of reading, as they may do in the present number of NATURE, what has been done in a single small province of Europe, in a city of only 104,000 inhabitants, in the equipment of a great University on modern lines. The completeness of the equipment, and the magnificence of the buildings of the new University of Strasburg are truly startling. It is to the divine right of learning knowledge, not to the divine right of ruling wrong that these modern palaces are erected. The *Zeit Geist* has indeed wrought revenges in the honour thus rendered to science and to philosophy, to literature and to art. Imperial Germany unites with her own province of Alsace-Lorraine to bestow 640,000*l.* upon the new University buildings, and to increase its existing endowments by a sum of 42,000*l.* per annum. Nor is this a solitary fact. During the last nine years France has spent nearly 1,000,000*l.* per annum on increasing and reorganising her University institutions. What has England to show against this? The Imperial Government has with the exception of the little Scotch and Welsh grants named above, done literally nothing. All else that has been done has been done mainly by a few individuals with great difficulty, on a very limited scale, in the teeth of all sorts of unintelligent opposition. Oxford Convocation consents, amid fierce debate, to spend 10,000*l.* on a physiological laboratory. Strasburg, in the meantime, has quietly spent 13,500*l.* for the same purpose; and this (Fig. 15, p. 561) is the smallest of the splendid group of institutes and laboratories in the new University. The Corporation of Nottingham—the only Corporation that has shown public spirit in this direction—has spent some 70,000*l.* upon an institution which includes a Natural History Museum *and* a Public Library, *and* a University College. Nottingham, has a population of 186,000 souls. At Strasburg, with a population of 104,000, a sum equal to this has been spent on institutes of chemistry and anatomy alone (Figs. 5 and 9, pp. 559-60), and nine times as much on the rest of the University buildings and fittings. The Corporation of Liverpool very generously contrived to accommodate its new University College in a disused lunatic asylum. But the whole of the buildings of Liverpool University College would go twice over into the Strasburg Institute of Chemistry (Fig. 5, p. 559). At Cardiff, the Town Council, after an attempt to thrust its University College into a still less suitable site, agreed to rent to it an old infirmary for its various scientific laboratories and lecture-rooms; but the Strasburg University possesses twelve buildings, every one of which is as large as the Cardiff building, and infinitely better adapted to the purpose. Owens College, the Mason College, the Firth College, owe nothing to corporate help: they are sustained by private benefactions. The Yorkshire College is also innocent of any municipal support. At Bristol, with a population of about 200,000 souls—nearly double Strasburg—funds privately subscribed to about 11,000*l.* have resulted in a ragged fragment of ill-assorted rooms to accommodate the local University College; the entire buildings for literature, science, and medicine being less than half the size of the Institute of Physics (Fig. 6, p. 559) at Strasburg. Lastly, the city of Newcastle-on-Tyne, with a population of 150,000, relegates its Science College to the cellars of a Mining Institution, where it is effectually buried from public notice. There is nothing at Strasburg comparable to this.

Englishmen will awake some day to the astounding neglect and apathy that have prevailed and still prevail; and then perhaps some statesman will think it worth his while to turn from endless party squabbles to useful national work. To reorganise the higher education of this country on a scale commensurate with that of other European countries, and o co-ordinate it with the rest of our educational system, and to equip it with buildings and appliances adequate o the needs of the time would

be a task of truly national importance, and one which must sooner or later be undertaken. It is a task befitting the ambition of an enlightened statesman. The Minister who shall succeed in the task will leave behind him in the memories of the nation a monument more enduring than marble.

TIMBUKTU

Timbuktu: Reise durch Marokko, die Sahara und den Sudan. Von Dr. Oskar Lenz. 2 vols. (Leipzig, 1884.)

AS we have already intimated, Dr. Lenz is about to set out on a new expedition, the purpose of which is to explore the unknown region lying between the upper waters of the Nile and the northern bend of the Congo. The reputation of a scientific explorer already earned by Dr. Lenz through his researches in the Ogoway basin will be much enhanced by the present work, embodying the results of a very successful expedition to North-West Africa, undertaken in the years 1879-80 on behalf of the German African Society. His original commission was restricted to a visit to Marokko, chiefly with a view to a more thorough survey of the Atlas highlands than had hitherto been effected by recent travellers in that still little known region. But the sanction of the Society was easily obtained to extend the field of his operations, so as, if possible, to embrace the still less known section of the Sahara lying between Marokko and the Niger. Timbuktu, the southern terminus of the caravan routes across this part of the desert, thus became the main goal of the expedition. The famous "Queen of the Wilderness" had been reached during the present century only by three European travellers—Major Laing in 1826, René Caillé in 1828, and Barth in 1853. To these illustrious names must now be added that of Oskar Lenz, who not only entered the place on July 1, 1880, mainly by a new route from the north, but also for the first time made his way thence westwards through the Fulah and Negro States of Moássina (Massina) and Bambara down the Senegal river to the Atlantic coast at St. Louis, capital of the French possessions in Senegambia. Hence the most important result of the journey has been to show that Timbuktu, hitherto regarded as practically inaccessible to Europeans, may be reached both through Marokko from the north and through the Senegal basin from the west.

It will be thus seen that the expedition naturally comprises two distinct sections—Marokko and the Atlas ranges as far as the Draa basin, which are exhaustively dealt with in the first volume; the western Sahara and Sudan described in the second volume, which moreover contains some valuable supplementary matter on the French settlements in Senegambia and on the physical constitution of the Sahara, besides an extremely interesting account of the present political and social relations in Timbuktu. Dr. Lenz travelled with a very small suite, limited to his interpreters, Haj Ali Butaleb and Christobal Benitez, and his trusty Marokkan attendant Kaddur. But, thanks partly to a letter of recommendation from Muley Hassan, Sultan of Marokko, partly to the character which he assumed of a Mussulman physician, he managed to pass without much serious risk through the turbulent and fanatical Arab, Berber, Fulah, and Negro tribes encountered along the route. Hence his conclusion, shared in by some other experienced explorers, that single travellers hampered by a minimum of impedimenta are likely to prove more successful in Africa than elaborately equipped expeditions, at least where the object is mere geographical discovery rather than extensive biological and ethnographic collections.

From the observations made at various points in recent times it has become more and more evident that the Sahara can no longer be regarded as having been a marine basin at least since the early Tertiary epoch. The theory may be said to have received its *coup de grâce* from Dr. Lenz, who plainly shows that the whole of the western section traversed by him is not a depression, as has been assumed, but an irregular plateau standing in the north at a mean elevation of from 800 to 1000 feet, and even at Taudeni, its lowest level, still maintaining an altitude of 400 or 500 feet above the Atlantic. The surface is varied with stony and sandy tracts, the so-called "areg" or "igidi," which have nothing in common with marine sedimentary deposits, but have, in fact, been produced by the weathering of sandstone, quartz, and carboniferous limestones, which appear to be the prevailing formations. It is thus evident that this part of the desert has been dry land for vast ages, and the same conclusion must be inferred from the numerous dried-up watercourses, whose deep channels are distinctly the effect of erosion. These wadies, many of which seem to have been flooded within the last few thousand years, radiate from the central highlands north and north-east to the Mediterranean, east to the Nile, south to the Tsad and Niger, west to the Atlantic. Hence down to comparatively recent times the Sahara was a well-watered and wooded region thickly inhabited by agricultural and pastoral communities, themselves the descendants or successors of still more primitive peoples, the contemporaries of Palæolithic and Neolithic man in other parts of the globe. In the Taudeni district, about 20° N., under the meridian of Timbuktu, Dr. Lenz discovered some implements of hard greenstone well worked and polished, and similar objects have also been found by Gerhard Rohlfs as far west as the Kufara oasis south of Tripolitana. The Asiatic camel is here a comparatively recent intruder, preceded by the Garamantian war-horse and by the elephant, trained also to war by the native Numidians and Phœnician Carthaginians. The crocodile even still survives in many of the pools and lakelets here and there marking the course of mighty streams, which formerly sent their perennial floods down to the surrounding marine basins.

Apart from possible cosmic influences, our author attributes the great change that has taken place within the historic period, not with Peschel to the dry north-east Polar winds, which in the Sahara yield to the prevailing northern and north-western atmospheric currents, but largely to the reckless destruction of the woodlands which at one time covered vast tracts in this now arid and treeless region. With the vegetation disappeared the moisture; all the large fauna became extinct, and the settled populations were succeeded by nomad tribes of Berber (Hamitic) stock, joined later on by Semites from the Arabian Peninsula.

Of Timbuktu Dr. Lenz gives on the whole a satisfactory account. During his residence in the place from July 1 to July 18, 1880, he was hospitably entertained by the Kahia, a sort of "Burgomeister," or civil magistrate, who is mayor, aldermen, and town council all rolled into one, but who possesses no political authority whatsoever. Since its capture by the Fulahs in 1826, when the fortifications were razed, Timbuktu has been a purely commercial town, a general emporium for Western Sudan, open to all comers—that is, to all the "Faithful," but unfortunately a constant bone of contention between the rival Tuarik (Berber) and Fulah tribes of the surrounding lands. At the time of Dr. Lenz's visit, the Tuariks, under their "Sultan" Eg-Fandagumu, were in the ascendant, but, beyond levying dues on the imports and exports, neither they nor the Fulahs ever interfere in the local administration, which is left in the hands of the Kahia. This office itself is hereditary in the Moorish family of Er-Rami, originally from the South of Spain, hence known as "Andalusi," and settled in Timbuktu since the sixteenth century. The present Kahia affects the title of "amir," and is said to be aiming at the sovereign power by making himself independent of the Tuarik and Fulah factions. In this he appears to be encouraged by the French, who have lately reached the Niger at Segu, and who have quite recently induced him to send an "envoy" to Paris.

During the journey from Timbuktu to the Senegal Dr. Lenz saw a good deal of the Fulahs, who are now everywhere interspersed among the Negro populations from Wadai and Darfur to Senegambia, and to whom apparently belongs the future of Central and Western Sudan between the Niger and Wadai. Unfortunately, in discussing the origin of this mysterious race, he revives the now exploded theory of a "Nuba-Fulah" family, first suggested by Friedrich Müller, the learned but somewhat venturesome Viennese ethnologist. At least Dr. Lenz goes so far as to say that, "touching the ethnographic position of this people Friedrich Müller has probably hit the mark in grouping together the Nubas and the Fulahs, whom he collectively calls Nubas, and divides into a western and eastern section" (p. 261). This might not be in itself so surprising but for the fact that he further on refers to the writings of G. A. Krause on the subject. Now Krause distinctly separates the Fulahs from the Nubas, or rather ignores the connection altogether, and allies them to the Hamites, calling them "Ur- oder Protohamiten." It may be added that with the materials now available (Lepsius, Nachtigal, Faidherbe, Newman, Krause, Reinisch, &c.), it seems possible to determine the mutual relations of all these peoples with some show of probability. But in any case the Fulahs are certainly not Nubas, nor are the Nubas Hamites.[1] Whether Krause is right in affiliating the Fulahs to the Hamitic group, "mag dahingestellt werden," at least pending further information. The type is distinctly non-Negro, differing from it in almost every racial characteristic—cranial formation, complexion, texture of the hair, figure, proportion of members, mental qualities. Dr. Lenz, who had numerous opportunities of studying full-blood specimens, was amazed at their striking resemblance to Europeans, and describes them as of light complexion, with slightly arched nose, straight forehead, fiery glance, long black hair, shapely limbs, tall slim figures, great intelligence. At the same time, since their diffusion among the Sudanese populations the Fulahs have become much modified by crossings with the Negroes and Arabs. "No territory or state is now found exclusively inhabited by pure Fulahs, who are everywhere intermingled with Negro and Arab communities" (p. 259).

[1] On this point the reviewer must refer the reader to his "Egyptian Ethnology." Stanford, 1885.

The work is illustrated with some good woodcuts and plates, mostly from photographs and sketches by the author, who has also added a general map of the region traversed, and as many as eight carefully prepared itineraries of its several sections. A. H. KEANE

OUR BOOK SHELF

Physical Arithmetic. By A. Macfarlane, D.Sc. (London: Macmillan and Co., 1885.)

THIS is a very thorough work, and one admirably adapted for the use of physical students: indeed, we think so well of it that we would recommend it for use in all schools and establishments where the subjects of which it treats are taught. There is a great amount of matter, tersely put and aptly illustrated by copious worked-out examples, and, in addition, there is good store of exercises to try the pupil's strength. Answers are appended, and a useful index crowns all.

What is its subject-matter? It treats, we should say, *de omni scibili*, and perhaps *de quibusdam aliis*. But to descend to particulars: there are nine chapters, and in these are discussed matters financial, geometrical, kinematical, dynamical, thermal, electrical, acoustical, optical, and chemical. Have we not rightly described its subject-matter above? Dr. Macfarlane has done much good work in other directions, and in this particular direction he gives us, not the result of two or three months' turning over of text-books, but what he has noted down since his student days; hence he speaks of what he does know. A diligent student, an original researcher, he has learned and assimilated methods arrived at by such masters in physics as Thomson, Maxwell, Tait, Everett, and Chrystal, and put them together here in orderly method. This method the author calls the *equivalence* method. "Each quantity is analysed into unit, numerical value, and, when necessary, descriptive phrase. The rate, or law, or condition, according to which one quantity depends on one or more quantities, is expressed by an equivalence. These equivalences are of two kinds absolute and relative; the former expressing the equivalence of *dependence*, the latter the equivalence of *substitution* or *replacement*."

We cannot give a brick, but we feel sure that the edifice to which we liken the book will be found to be constructed on thoroughly sound principles, and that no student who buys it on our recommendation will regret having done so.

It would take a very long time to test the furniture (*i.e.* the examples); upon its suitability, we cannot now pronounce an opinion; moreover, each student will have his own particular room to explore: after a visit to all the rooms, each appears to be quite *comme il faut*.

Coordonnées parallèles et axiales. Méthode de Transformation géométrique et Procédé nouveau de Calcul graphique, déduits de la Considération des Coordonnées parallèles Par Maurice D'Ocagne. (Paris: Gauthiers-Villars, 1885.)

TWO fixed points, A, B, called the *origin of co-ordinates*, are taken, and through them are drawn two parallel straight lines, Au, Bv; these are called *axes of co-ordinates* (or co-ordinate axes). Lengths, AM, BN, measured on

these lines, upwards positive, downwards negative, are the *co-ordinates* of the straight line MN. So much for the *parallel* co-ordinates. Take a straight line, Ox, for *axis*, and on this line a point, O, the *pole* of the system. A straight line is determined by the angle θ, which it makes with the axis, and by the length λ from O of its intersection with Ox. These are the *axial* co-ordinates. Elementary details of these two systems are given for the former in Chapters I.-V. (pp. 1-33); for the latter, in Chapters VI.-VIII. (pp. 36-43). Several applications to examples are discussed. Chapters IX., X. (pp. 52-73) are devoted to a "Méthode de transformation géométrique fondée sur la simple comparaison des coordonnées parallèles avec les coordonnées rectangulaires." The "procédé nouveau" is the closing portion of this chapter (pp. 73-82).

The illustrations in the pamphlet are mostly taken from curves of the second degree, but these co-ordinates—a kind of tangential co-ordinates—are useful for such questions as the following:—Find a curve such that a portion of a tangent intercepted between the point of contact and the axis has a constant length (the tractrix is such that the area between it and the axis is equal the area of a semi-circle, radius equal distance from origin to cusp of tractrix); find a curve such that the portion of a perpendicular TI to the axis Ox drawn through the foot T of the tangent, limited on one side by Ox and on the other by the corresponding normal, has a given length (the curve, of course, is readily seen to be a cycloid).

The pamphlet is an interesting one, and suggests methods of procedure which in some cases have advantages over other methods more familiar.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

The Colours of Arctic Animals

I AM sorry that I cannot agree with my friend Mr. Meldola as to the insufficiency of the explanation of the white coloration of Arctic mammals and birds as due to protective adaptation, since it appears to me that there is no important group of facts in natural history of which the explanation is more complete; while on the other hand I venture (though with some hesitation) to question the basis of his counter explanation, as I am not aware of any sufficient proof that colour, *per se*, affects the radiation of low grade heat. At all events I feel tolerably certain that this cause, if it exists, has had no perceptible influence in determining the white colours of Arctic animals.

I am not myself aware of there being "many species" possessing the white coloration as to which there is any difficulty in seeing the advantage they may derive from it, and there is certainly a large body of facts showing that *colour* is, in almost all animals and in every part of the world, more or less protective or adaptive. If the white coloration of Arctic animals stood alone, it might be thought necessary to supplement the protective theory by any available physical explanation, but we have to take account of the parallel cases of the sand-coloured desert animals and the green-coloured denizens of the ever-verdant tropical forests; and though in both these regions there are numerous exceptional cases, we can almost always see the reason of these, either in the absence of the need of protection or in the greater importance of conspicuous colouring. In the Arctic regions these exceptions are particularly instructive because in almost every case the reason of them is obvious. Let me call attention to a few which now occur to me.

In the Arctic zone the wolf does not turn white like the fox, the reason evidently being that he hunts in packs, and concealment from his prey is not needed. So the musk-sheep and the yak, though both exposed to the extremest cold, are not white, because they are both swift and strong and need no concealment from their enemies. For the same reason neither the moose, the caribou, nor the reindeer are wholly white. Again, the glutton and the sable are dark-coloured, though inhabiting the coldest regions, and this is clearly because they are arboreal, and are better concealed from their prey by a dark than a light colour. If any useful protection from cold were to be obtained by a white coat, we should expect it to appear in such a case as the Esquimaux dogs, exposed for countless generations to the severest climate. But they gained the required warmth by a thickening of the woolly undercoat in winter, as do many other animals; and this suggests the general proposition that it will be always easier and safer to gain warmth in this way than by a modification of colour, which could certainly have but a very small effect, and might often interfere with adaptations of far greater importance. Exactly analogous cases occur among birds. The raven is, perhaps, the extremest Arctic species, but, feeding on carrion, it has no need of concealment in approaching its prey, and thus it keeps its jet black coat in the depths of the Polar winter.

The physical explanation of melanism in butterflies and some other insects, on the other hand, seems to me to be probably a sound one; but even that requires more evidence and a fuller knowledge of the habits of the species before we can admit it as proved. It may be that the dark colouring is protective, assimilating with the surroundings of the insect when at rest, and this can only be decided by observations specially directed to the point in question.

But even if, in this case, the dark colour has been produced in order to favour the absorption of the direct rays of the northern sun, it affords no support whatever to the totally different case in which the radiation of the obscure heat from an animal body has to be checked. I may, perhaps, be ignorant on the point, as it is rather out of my line, but I am not aware of any good experiments to determine the influence of colour *per se*, as distinct from the structure and surface-texture of coloured substances, on the radiation or absorption of heat of a low grade of temperature, and from a dark source. The only authority I have at hand (Ganot's "Physics," eighth edition) seems rather to imply that colour has no effect in such cases, for I find it stated, at p. 338, that the radiating power of *lampblack* and *whitelead* are identical, both being given as 100, while *Indian ink* is only 88. Again, at p. 352, the absorptive power of these two substances is given as 100, the source of heat being copper at 100° C., while that of Indian ink is given as 85. This seems to show that surface-texture or molecular structure is the important point, while colour has no effect whatever.

In order to determine experimentally whether white fur or feathers are inferior to black as radiators of animal heat, it would not do to employ stained or dyed materials, because the pigments employed might affect the texture of the surface, and produce an effect not at all due to the colour. A fair test would be afforded by two samples of cloth or flannel woven from white and black natural wool respectively, the wool to be obtained from the same breed of sheep, and, if possible, from the same district, while the material must be as nearly as possible identical in weight and texture. I shall be glad to learn from Mr. Meldola, or any other of your readers, whether any experiment of this kind has been made, or whether there is any valid reason for believing that the radiation of animal heat is at all affected by colour alone.

ALFRED R. WALLACE

Civilisation and Eyesight

THE statistics of eyesight given by Mr. H. B. Guppy in NATURE (p. 503) relating to the inhabitants of the Solomon Islands as tested by the Army test-dots, bring us nearer, I think, to the solution of the question of the relative acuteness of vision of civilised and savage races than any previous communication which has appeared in your columns, as we are able to compare them with statistics obtained under similar conditions in this country. The Anthropometric Committee of the British Association gave a series of tables in their Report for 1881 showing the results of their inquiries into the sight of different classes of the community, carried out by means of the Army test-dots; and for the purpose of comparison with Mr. Guppy's figures I have extracted the returns relating to men employed in agriculture and other out-door occupations as most nearly agreeing with the conditions of life of savage people, and have embodied them, together with Mr. Guppy's, in the following table:—

Distance in feet at which the Army test-dots were distinguished	English agricultural and out-door labourers, age 16 to 45 years. No. of obs.	Solomon Islanders, age not stated. No. of obs.	English agricultural labourers, &c., age 21 years. No. of obs.
5 to 10	1	—	—
10—15	1	—	—
15—20	4	—	1
20—25	8	—	1
25—30	15	—	1
30—35	29	—	2
35—40	34	1	3
40—45	27	0	3
45—50	40	0	8
50—55	55 *	7 *	11 *
55—60	52	2	8
60—65	40	7	4
65—70	40	3	2
70—75	20	2	2
75—80	9	—	1
80—85	3	—	1
85—90	2	—	—
90—	5	—	1
Total	385	22	49
Average	52·1	57·5	52·5
Mean	55·0	55·0	52·5

* Mean or value of greatest frequency.

Mr. Guppy's figures are too few in number, and too irregular in their relation to each other and to the columns of figures on either side of them, to be accepted as representative of the range of vision of the Solomon Islanders, and he must have stumbled on some of the better examples, or else the short-sighted men have not presented themselves to him for examination. Nevertheless, taking the figures as they stand, they give no support to the belief that savages possess better sight than civilised peoples. Mr. Guppy gives 60 feet as the distance at which the test-dots were distinguished, but the average of his figures is 57·5 feet, or only half a foot more than Prof. Longmore worked out, from observations on British recruits, as the distance which the test-dots ought to be seen in good daylight. Judging from the run of the figures, I should place the so-called "normal" vision of the Solomon Islanders at 55 feet, or possibly at 52·5 feet, like the English labouring classes of the age of twenty-one years, as our figures representing that age are remarkably uniform in their distribution, and therefore near the truth. The average of the Solomon Islanders is, it is true, higher by 5 feet than the English in my table; but this is obviously due to the absence of observations on the less perfect-sighted individuals belonging to the former race. Even when the test is one of seeing objects at the greatest distance, the best savages are inferior to the best English by about one-third. Mr. Guppy evidently believes that the Solomon Islanders possess very superior sight compared with ourselves, especially for distant object; and Mr. J. A. Duffield, who read a paper recently, at the Anthropological Institute, on the natives of some adjoining islands, was still more firmly of this opinion; but it is obvious that the question cannot be decided by general impressions, nor by the result of comparisons with sight the value of which we are ignorant. Travellers naturally record cases in which their own sight (which they believe to be good, but which may be very bad) is outstripped by savages, but do not encumber their pages with negative evidence of the kind. Their mistake lies in confounding acuteness of vision with the results of special training or education of the faculty of seeing—results quite as much dependent on mental training as on the use of the eyes.

Bolton Row, Mayfair, April 13 CHARLES ROBERTS

Far-sightedness

ALLOW me to corroborate the report of your correspondent, whose letter appears in NATURE of April 2 (p. 5 6) as to the visibility of very distant terrestrial objects. In the spring of 1837 I was travelling from Rome, northwards, by "Vetturino," and from the summit of the Apennine on the road between Florence and Bologne, I saw, with astonishment, the whole range of the Swiss Alps, not merely distinguishable but conspicuous. Measured on the map in a direct line the nearest part of the range was distant about 200 miles. The extreme portions, including Mont Blanc, were considerably more. I have no doubt that the atmospheric conditions were unusually favourable. For when I asked the Vetturino what mountains they were, he, having often passed that way without seeing them, said they were nothing but clouds. I told him that I knew a snow mountain when I saw it; and as a peasant, living on the spot, shortly passed, I renewed my inquiry—to which he immediately answered, to my surprise, that they were the mountains of Switzerland. J. HIPPISLEY

Stoneaston, April 7

ON September 3, 1874, from the Piz Muraun, near Dissentis, I saw the white dome of Mont Blanc, distant about 110 English miles. As the Piz Muraun is only about 9500 feet I was sceptical, till a reference to maps showed a line of intervening depressions. I feel sure that some Alpine tourists will be able to furnish Herr Metzger with cases of mountains identified at distances vastly exceeding this of mine. E. HILL

Cambridge, April 8

The Pupil of the Eyes during Emotion

IN connection with the above subject the following experiment may be of interest to your readers. It is one I made many years ago when studying the border-land between physiology and psychology. At that time I showed and explained it to a number of my friends.

In this experiment it appears to the observer as if I had control over the muscles of the iris, as I can make the pupil of the eye large or small at will. Placing myself in front of, and looking towards, a window or other bright light, the observer is desired to watch the pupil, and say when to contract or expand it. On the order being given, the pupil is seen to expand or contract as desired. This experiment can be easily made by any one in the following manner:—The eye is directed towards the light and a point looked at, the eye being kept steady during the whole experiment. Under these conditions the bright light causes the pupil to contract automatically, and when desired to expand it all that is necessary is to take the attention away from the eye and fix it on some other part of the body—say, by biting the tongue, pinching the arm, &c. By these means the sensitiveness of the retina is, for well-known reasons, reduced, and the pupil automatically dilates. To cause it again to contract, the mind has simply to be recalled to the eye and attention given to the visual impressions.

This experiment supports the explanation given by Dr. Herdman in Mr. Clark's letter in NATURE, vol. xxxi. p. 433, and also the explanation given by Dr. Wilks at p. 458. When the mind is under the influence of fear, the energies are diverted from the eyes and the pupils dilate on account of the reduced sensitiveness of the retina. While in anger, sight being powerfully called into action, the sensitiveness of the retina is increased and the pupil automatically contracts, so that generally we might expect that during those emotions in which the eyes are called into action the pupils will be small, and that when the nervous energies are directed away from the eyes to other centres, the pupils will be large. JOHN AITKEN

Torquay, April 8

Notes on the Geology of the Pescadores

DURING a stay of two days in Makung Harbour in 1877, I collected a few notes on the geology of this small group, which has, from its recent occupation by the French, been brought before the notice of the public. These islands, which were briefly described in the last number of NATURE (p. 540), have a characteristic appearance, being flat-topped, 100 to 200 feet in height, and presenting a rather barren aspect from the scarcity of trees and shrubs. Dampier, who visited them in 1687, described them as "much like our Dorsetshire and Wiltshire Downs," producing "thick, short grass and a few trees," a description equally applicable at the present day.

As far as I could ascertain, the whole group was of basaltic formation, the columnar structure being well developed, columns 30 to 40 feet high being observable in the faces of some of the cliffs. In the places I visited the cliffs were built up of two basaltic streams superimposed, the two masses towards their junction being scoriaceous and amygdaloidal, and separated by a layer three inches thick of a red, soft rock or laterite. The

cavities of the vesicular parts of the rock were often filled by calcite or hæmatite.

The apparent absence of any cone or tuff deposit, the compact and columnar structure of the rock, and the vertical position of the columns, seemed to show that the whole had been originally one continuous sheet of submarine lava-streams, which had been subsequently elevated and cut up by the waves into the several islands—a conclusion which was supported by two other circumstances: the form of the islands and the shallow intervening depths (6 to 9 fathoms).

It is noteworthy that several of the islands sloped away gradually west-south-west to south-west, a direction coinciding with that of the submarine slope in this part of the Formosa Channel. From this circumstance it would seem that the succession of lava-streams flowed in a south-west direction, and that their source lay in the north-east portion of the group.

17, Woodlane, Falmouth, April 11 H. B. GUPPY

A New Bird in Natal

SOME months ago, Mr. Fereirra, a member of my congregation, informed me that he had shot some time previou-ly a bird in the early morning which neither he nor any of his neighbours had seen before. From his description of it I concluded that it probably belonged to the goat-suckers, and on examination of the skin I find that the supposition is correct.

A day or two ago he brought the skin to me: it had been stretched against the wall of his room to display its plumage to the greatest advantage. The measurements which I give cannot therefore be perfectly accurate. One of its long plumes has been broken by a pellet, but otherwise the skin is in tolerably good preservation, and I trust that it may be well stuffed and set up, for the bird is certainly not mentioned in the first edition of Layard's "Birds of South Africa," nor yet in any of the books or catalogues in my possession, and the bird is in itself so very remarkable that one cannot help thinking that it would have been described in the books I have had it been known. I will deposit the skin in the Natal Museum, Pietermaritzburg. The bill is that of a goat-sucker, strongly fenced with strong hairs. The length of the body from tip of the bill to the insertion of the tail is 6 inches; length from tip of bill to tip of tail, 11½ inches; length between tips of wings—probably stretched too much—24 inches.

The colour is the usual brown of the family—bars on the tail of brown black, and mottled bars of light and dark brown; feathers, eight in number, the longest on the outside of the tail.

Wings: Primariæ, 9 in number.

Length of the 1st feather, 7½ inches.
,, 2nd ,, about an inch shorter.
,, 3rd ,, shorter than second; the following three about the same length as the 3rd.
Length of the 7th feather, 7½ inches.
,, 8th ,, 11½ ,,
,, 9th ,, 27½ ,,

The first seven of the primariæ are tipped with white, the 2nd and 3rd rather broadly, the 1st scarcely. The 8th becomes greyish towards the tip, and the ribs of the 7th and 8th are brown, while the others are black. Two-thirds of the length of these feathers are black; but a band of white, narrower on the first and increasing to about 3 inches broad on the 8th feather, extends along the roots and middle of them, and crosses over to the 9th long feather, which, for 21 or 22 inches, is of a dullish silver-gray. The secondariæ are tipped with white, with the exception of the 1st and 2nd, which only give indications of being so; they are generally black-brown, with markings of light brown. There is a reddish ring around lower back part of the neck.

The breast is light gray, generally with light brown markings in bands.

Its feet are those of a goat-sucker, but on comparing the foot of the *Caprimulgus europæus*, as drawn by Van der Hoeven (vol. ii. plate 7, Fig. 9, ed. 1858) I find the teeth of the comb of the middle toe much broader and stouter than that of the former. There are only four teeth, with a smaller or false one at the root of the nail. The length of the nail is about one-eighth of an inch, and the breadth of tooth is therefore about one-sixteenth of an inch.

This bird is evidently very closely related to the pennant-winged night jar, or long-shafted goat-sucker (*Macrodipteryx africanus*); but the markings are very different, and the long-shafted feathers are not more than 17 inches long, while those of this bird are more than 27 inches in length, and they do not display any inclination to form a long naked shaft, but are clothed or webbed on both sides from the root to the tip.

It is very singular that this bird should only have become known in this district in 1884. The farmers are close observers, as also are the Kaffirs, but no one has ever seen it. It is the more singular since it was shot on a farm that has been long occupied, and that by a farmer who in his younger days was accustomed to help collectors of birds for our European museums. Perhaps the long and severe droughts, said to prevail this year in the interior, may account for its presence in Natal. JAMES TURNBULL

Pastorie, Grey Town, Natal, March 2

C. T. E. VON SIEBOLD

CARL THEODOR ERNST VON SIEBOLD was born at Würzburg, in Bavaria, on February 16, 1804. His brother was the well-known traveller and philologist. Carl was brought up chiefly, under the superintendence of his father, for the medical profession, and he carried on a practice for a few years as a physician at Heilsberg and Königsberg. In 1835 he received the appointment of Master of the Lying-in Hospital at Dantzic. Early in his life he showed an interest in zoology, and in 1840 he removed from Dantzic to Erlangen, where he taught comparative anatomy, zoology, and veterinary medicine. In 1845 he was appointed Professor of Zoology at Friburg, and shortly afterwards he made a prolonged sojourn on the Adriatic. At this time he worked with immense zeal and ardour at the anatomy of the marine invertebrates, and as the result of this work and his lectures combined he commenced the elaboration of his well-known "Lehrbuch der vergleichenden Anatomie der Wirbellosen Thiere." In his preface to this work, which has been translated into English and French, he insisted on the importance of a knowledge not only of the minute anatomy but also of the developmental stages of the forms described. Generous aid in the completion of this at the time most excellent treatise was given to him by C. Vogt, H. Stannius, A. Krohn, H. Koch, and A. Kölliker, and in 1849 he founded, in connection with the last-named of these eminent biologists, the *Zeitschrift für wissenschaftliche Zoologie*, a journal which has ever held a leading position among the scientific publications of our day, and one which is still known and esteemed wherever zoology is studied.

In 1850 von Siebold was appointed to the Professorship of Physiology in the University of Breslau, and also received the charge of the Physiological Institute of that city.

In 1853 he was appointed Professor of Zoology and Comparative Anatomy in the University of Munich, and Director of the Zoological and Zootomical Cabinet in that city. These positions he filled during the remainder of his life.

Shortly after his appointment to the Munich Professorship he commenced an elaborate series of investigations into the vexed question of "Parthenogenesis," entering on the subject with a belief that facts had been misunderstood; and his treatise on this phenomenon, as found by him to actually exist in bees and moths, was a genuine contribution to science. This work was published at Leipzig early in 1856, and was translated by Mr. Dallas the following year into English.

Somewhat earlier in date he published a memoir on "Tape and Cystic Worms, with an introduction on the Origin of Intestinal Worms," which was deemed worthy of being translated into English, by Prof. Huxley, for the New Sydenham Society. The good that this translation effected by introducing some scientific facts to the notice of our medical men it is not easy to calculate.

In 1858 the Royal Society elected him as one of their honorary members. In 1867 he was made a correspond-

ing member of the Institute of France. There seems little need to enumerate all the honours that were conferred on him during the half century that he was known as one of the distinguished zoologists of Europe.

In the important and indispensable catalogue of Scientific Papers published by the Royal Society, we find a list of over 130 memoirs ascribed to Prof. Von Siebold.

Failing health during the last few years interrupted this, up to 1874, steady flow, and Dr. Ehlers undertook much of the labour of editing the *Zeitschrift*. Those who had a personal knowledge of Von Siebold will remember his pleasant and friendly manners, the readiness with which he placed at the students' disposal all the information in his power, and the visitor to the Zoological Museum at Munich will not soon forget the vast stores, not only collected, but scientifically arranged under the superintendence of Von Siebold.

THE EGGS OF FISHES[1]

II.

THE condition of the fish-fauna of the various grounds may be estimated to some extent by the number of the floating ova near the surface. We have seen that Sars found the water crowded with the multitude of ova off the Loffoden Islands, where enormous numbers of cod are captured. In our seas no fishing-bank is so prolific, the greatest number of ova occurring on Smith Bank, off Caithness, and the next on the rich grounds off the Island of May—both of which present a great contrast with the meagre supply of eggs of round fishes floating in our own bay. The proportional numbers in each case accord very well with the captures of adult cod in the several areas.

No sight can be more interesting to the naturalist than the surface of the sea, in the condition just mentioned, about the beginning of April. The rough water of the great fishing-grounds—such as off Smith Bank, and somewhat further from land—is enlivened by large groups of gulls, guillemots, and the ubiquitous gannets, apparently feeding on the smaller fishes which have been attracted to the surface by the wealth of food. At short intervals the long dorsal fin of a large killer appears above the surface, and the water behind it is churned into foam by the powerful strokes of its tail; while a small group of bottle-noses (another kind of toothed whale) is recognised by the noise and foam, as one or more leap from the sides of a huge wave. The tow-net collects large quantities of ova and minute fishes which have just escaped from the egg. It further shows that innumerable minute crustaceans, such as Copepods (*e.g. Calanus finmarchicus*, Gun., and *Temora longicornis*, O.F.M.), multitudes of the young, or nauplius-stage, of sea-acorns, Sagittæ, and peculiar Annelids (*Ioida*) are present. It is evident, therefore, that the young fishes are placed in the midst of a rich surface-fauna, the more minute forms of which would readily serve as food.

In the foregoing remarks on the floating eggs of British food fishes, those of the cod, haddock, and whiting, have been chiefly alluded to. We shall now refer to others, either wholly or partially unknown till this year. I have already mentioned that Sars found certain floating eggs mingled with the former on the surface of the sea, and identified the young, after hatching, as gurnards. In the present case the eggs were removed from the adult gurnard, and hatched at St. Andrew's in about a week, so that a further step has been made. The eggs of the gurnard float as buoyantly as those of the cod and haddock, but they are considerably larger. Each has a very distinct oil-globule opposite the germinal area, which generally is directed downwards. Some are of opinion that the floating of the eggs of such fishes as we are now considering is due to the oil-globules, but the eggs of several fishes, *e.g.* those of the salmon, have a larger quantity of oil, and yet they do not float. The specific gravity of the eggs is slightly less than that of the sea-water; but the precise connection between the floating of the living ova and the sinking of the dead has yet to be made out. Such would form, indeed, a most valuable and interesting subject for investigation at the Marine Laboratory. So easy is it to hatch the eggs of the gurnard that the water in the instance just narrated was not changed. The rapidity with which the development of the embryo goes on in the egg is remarkable, for in 7 or 8 days the young are extruded, whereas in the salmon, for instance, no less than 60 days are required even in a room with a temperature much higher than that of the open air. If the eggs of the salmon are permitted to hatch in an ordinary river, a period of from 95 to 120 days is usually necessary for hatching. The very great difference, therefore, between the marine and freshwater fishes in this respect is apparent.

The only flat fish in which the ova had been found to float was the plaice, which Dr. Malm had examined in the Baltic. In May of this year, however, the eggs of the common flounder in St. Andrew's Bay showed the same feature. They floated buoyantly on the surface of the water. Prof. Huxley at this time having suggested that perhaps the floating or sinking of the ova was a question of temperature, the eggs of this species were used in some experiments. They had been removed from the fish on May 2, and placed in the Marine Laboratory. On the 5th the majority still remained on the surface, those on the bottom having been carried down by the attachment of sand-grains. A number from the surface were placed in a test-tube. After standing an hour the majority were floating on the surface, one or two lay on the bottom, while others rested in mid-water. Placed in a vessel of water at 98°, the eggs exhibited lively movements for several minutes, being carried up and down by the currents, but never remaining at the bottom. The test-tube felt quite warm to the touch, yet the eggs floated, and remained floating, as buoyantly in the warm water as in the cold, so that their floating in the sea is not a question of temperature.

An interesting sequel, further, remains to be told in connection with this experiment, in which the test-tube had been placed aside and forgotten. On May 10, while explaining the matter to Prof. Ewart, he noticed motion in the test-tube, and I found that the eggs which had been raised to a temperature of 98° had given birth to little flukes, which thus survived the exigencies of their surroundings, both as regards temperature and water. These little creatures are as symmetrical in outline as the young cod or haddock, an eye being placed on each side of the head, while in the adult flounder, as you are all aware, both eyes are on one side (the right or coloured one). The pigment is quite different from that of the young cod, being of a peculiar pale olive or brownish yellow by transmitted light, and the cells seem to be less branched. Their motions also diverge from those of the cod, for the little creatures hang head downwards in the water, either perpendicularly or obliquely, the yolk-sac being on the upper line of the slope. They then move upward, hang as formerly, or slowly descend, repeating these motions frequently. The young cod, on the other hand, dart nimbly about near the surface of the water, and bear themselves quite differently.

But to return to the ova. Before the summer that has just passed, it was not known whether the ova of the turbot, sole, and lemon-dab—all important and valuable food fishes—floated or sank. Accordingly such fishes were a source of special interest. It was not till the end of June and in July that perfectly ripe turbot could be procured, and then the small ova were found to float as

[1] Introductory Lecture delivered to the Class of Natural History in the University of St. Andrews, on November 10, by Prof. McIntosh, LL.D., F.R.S. Continued from p. 536.

buoyantly as any of the foregoing; and the same was proved to be the case with the eggs of the sole and lemon-dab—all these, moreover, being obtained in the act of spawning far out at sea, and in comparatively deep water. The ova of the long rough dab and the common dab were also added to the list of those with floating eggs. The notion, therefore, that such fishes seek the shallow water for the purpose of spawning is visionary, and mainly rests on the preconceived opinion that the eggs are deposited on the bottom.

Amongst the eggs of the cod floating on the surface of the water off the Island of May, in April, were vast numbers of very young sand-eels. The late Mr. Buckland states that they spawn in "May, June, and September," and that they deposit their eggs in the sand. They would rather seem to spawn in spring, and their eggs probably avoid the sand as much as possible by floating on the surface of the water. Sand is a most objectionable site for the eggs of certain fishes, and no less so for the embryo.

Without going into further detail, it is evident, therefore, that the eggs of many of the most valuable food fishes thus float near the surface of the sea, *e.g.* those of the cod, haddock, whiting, bib, and other Gadoids, mackerel, gar-fish, red mullet, weever, plaice, long rough dab, common dab, lemon-dab, sole, common flounder, and probably sand-eels. There is hardly a marine fish, excepting those of the herring group, which appears in our markets, but has this remarkable provision in regard to its eggs. It would also appear that some of these eggs range throughout the water, so as to be caught by a tow-net sunk many fathoms beneath the surface.

There can be little doubt that this wonderful provision is one of the main reasons why such marine fishes have held their own in the struggle for existence—not only with respect to their predatory neighbours, but still more in regard to the persistent inroads on their numbers made by man. Marine fisheries have hitherto been conducted as if practically inexhaustible, both lines and trawlers taking as much from the sea as possible, while no margin has ever been afforded the spawning fishes.

Let us for a moment glance at the working of this arrangement. The comparatively small eggs of the chief food fishes rise to the surface, or nearly to the surface, wherever the shoals of adult fishes happen to be feeding, and this occurs not during a brief period, but it extends over a considerable space of time. The tiny young in their helpless state are carried, along with multitudes of eggs, by every tide into sheltered creeks and bays, in the shallow water of which they find both safety and food. We are familiar with these tiny embryos, furnished with a yolk-sac—and so fragile that they would fall an easy prey to hosts of swimming crustaceans on which, in the adult state, they would hardly deign to feed—near the surface of the sea; but a hiatus yet remains in the history of the young cod, for instance, between the date of complete absorption of the yolk-sac and that in which it is found swimming in the forests of tangles in the laminarian region—for example, off the Castle and Pier Rocks, or even venturing into the harbour. There, as a rule, it is free from the pursuit of both liners and trawlers, and quietly grows apace, feeding on the swarms of minute crustaceans and the myriads of very young mussels which characterise such a region. In the early part of the season they range from one and a half to two inches, and are variegated with a series of pale spots, somewhat rectangular in outline. The general colour is olive, lighter or darker according to circumstances, though a few of the larger examples have a reddish hue, such as signalises the "rock-cod" of the liners, but the pale spots are similar. Many of these young cod are infested by parasitic crustaceans (*Chalimus*), which adhere by a long median process that penetrates the skin. They are accompanied in the laminarian region by the young of the coal-fish, whiting, pollack, rockling, long-spined cottus, and lump-sucker.

Sars is of opinion that the intermediate stage—about which, as above-mentioned, our knowledge is imperfect—is passed by the young cod-fish in the shelter of the jelly-fishes, on the rich grounds off the Loffoden Islands. It is true that once or twice young cod, of the intermediate stage, and coal-fish have been caught in our seas in the tow-net in July, but the result of the present observations gives no support to this view. The jelly-fishes in our seas are not in sufficient numbers at the time of the intermediate stage, especially in regard to the spawning in April, to act as shelter-forms to the young fishes. It is probable that as soon as they gain sufficient strength to withstand the force of the ordinary ebb-tides, they remain amongst the tangles and other seaweeds of our rocky shores, to which they have meanwhile been carried by the currents. While a few, therefore, are found here and there near the surface of the sea amongst other pelagic types, the majority of those in the intermediate stage probably swim somewhat deeper.

The after-history of the little cod of one and a half to two inches, which are found in considerable numbers off the Pier and Castle Rocks in the beginning of July, appears to be as follows. They remain in the laminarian region for some months (many being captured even at this season), and rapidly increase in size on the rich and abundant food placed within easy reach. Moreover, it is probable that in this region they are much less liable to the attacks of predatory fishes than in the open sea. We find, indeed, that, while young haddock and whiting abound in the stomachs of cod, haddock, gurnards, and other fishes, it is rare in our seas to find young cod of the size we are now considering. Prof. Sars, on the other hand, procured them abundantly in the stomachs of the pollack (a fish which swims high) off the Norwegian shores; but it has to be borne in mind that they form the chief feature of the young fish-fauna of the region at the time indicated. As they grow larger and bolder, they seek deeper water, and are found in numbers near rocky or rough ground, such as off the Bell-rock, and the North Carr rocks, and indeed all along the rocky eastern shores. They then mingle with their progenitors on the various fishing-banks, and are caught in numbers by both hook and trawl. The main cause of this migration from the shore seawards is probably the nature of the food, which, as the animals grow older, becomes of a different character, the larger Crustacea especially—such as hermit-crabs, Norway lobsters, and many short-tailed crabs—being eagerly sought after, along with various kinds of fishes. So far as our knowledge at present goes, a cod probably takes between three and four years to attain full growth.

A feature which requires special mention is that, when the shoals of young cod are watched at any of our rocky shores during several months, one is struck by the fact that throughout the period many small forms are present, that is, some do not appear to have grown; but we have seen that the spawning of the adult fishes extends over a considerable period, and, further, that only a portion of the eggs in any given fish come to maturity at once. There is thus a succession of young fishes coming at a certain stage shorewards, and another migrating outwards. This and other facts already mentioned show how intimately the in-shore ground depends on the off-shore; in other words, the eggs and very young fishes are carried from the offing by every tide during the season, while a constant stream of young fishes of a large size goes to swell the ranks of the adults beyond the three-mile limit. The prosperity of the one region is thus intimately associated with that of the other.

In this rapid sketch, then, it will have been observed how complex are the relations which surround the increase of marine fishes. Conspicuous above all others, however, is the remarkable provision whereby the eggs of

almost all the chief food fishes, except the herring group, float at or near the surface of the water—so that they are carried hither and thither by every surge of the tide, or more steadily borne by the deeper currents to stock anew exhausted waters. The minute and imperfectly-developed embryos and the delicate young, moreover, are conveyed into regions best suited for their future growth and well-being. Further, we cannot but be impressed by the fitness of the arrangement which ordains that these young fishes are placed from the first amidst a rich surface-fauna of minute forms which serve them as food. These range from the microscopic Infusoria, which cause the crest of every ripple at the ship's side to sparkle with light and the tow-nets to gleam like tunnels of fire; the wonderful Plutei, or painter's easel-like larvæ of star-fishes, swarms of larval sea-acorns, Copepods, and the beautiful zoeæ of the higher crustaceans. Besides these, are the peculiar Appendicularïæ and Sagittæ, and countless myriads of larval mussels, which in summer crowd the surface of St. Andrew's Bay, and at a still later stage, as they are forsaking their pelagic existence to settle on the stones and seaweeds, form the food of the more advanced young cod, haddock, whiting, coal-fish, pollack, and others that seek shelter for a time amidst the shaggy belt of tangles encircling the rocks. The latter thus in their larval state, by nourishing in their profusion the delicate young of the food fishes, in a sense repay the wise conservancy bestowed by the Town Council of this city on the fine mussel-beds of the Eden. It will, moreover, be observed that it is not only the eggs of the higher marine animals which float, but that for a long time zoologists have been familiar with the pelagic eggs and young of many invertebrate groups of importance. How else, indeed, could the ubiquitous mussels, the sedentary oysters, and the equally stationary sea-acorns and barnacles be spread throughout the ocean? Moreover, not only do these swimming larval forms nourish the very young food-fishes around them, either directly or indirectly, but as they—for instance, the young crabs, lobsters, star-fishes, and mussels—grow larger and older, a kind of rain, so to speak, of such forms takes place from the surface to the bottom, which is readily taken advantage of by the larger fishes, and thus the wonderful cycle is completed.

Finally, I need not point out to you the importance of the Marine Laboratory, to which I have already alluded, and at which the foregoing and other investigations were made during the summer. We have facilities in this and in the Practical Class, which are unusually favourable for study and research, but at the same time our responsibilities are not diminished by such advantages. We must all render an account of our stewardship. When I mention that many facts have yet to be determined in regard to our common food-fishes—their development, rate of growth, their life-histories and migrations—that we have much to find out as to the best methods of increasing such valuable fishes as the cod, the haddock, the sole, and turbot, and of maintaining that increase, it will be apparent that such problems are not only of moment to us but to the country, and that we cannot begin too soon to attempt their solution, as well as to increase our knowledge in regard to many of the lower forms of animal life.

THE NEW UNIVERSITY OF STRASBURG

THE following account of the new university buildings of Strasburg is taken, with a few abbreviations, from an article contributed to our contemporary *La Nature*, by M. Charles Grad, who is himself a deputy to the Imperial Reichsrath from Alsace.

On Monday, October 27th. 1884, the new buildings of the University of Strasburg were opened with due formalities. These buildings form an entire quarter of the city, and constitute a magnificent series of palaces for the prosecution of science. No city in Europe, not even excepting the great capitals, can show such a rich provision for higher education, or one in which the various parts are so admirably combined. Every branch of study has its own proper and distinct location allotted to it, with laboratories, museums, library, and special appliances. It has been done on the large scale, and most successfully. The Imperial Government and the representatives of the Alsatian population arrived at an understanding, and vied in their efforts to endow the province of Alsace-Lorraine with a school of learning unrivalled in its arrangements and in its wealth of buildings. Even those who were most severely touched by the annexation to Germany, agree that in raising this splendid monument —the new University of Strasburg—the one wish has been to serve the interests of science apart from all sinister or narrow national considerations.

The former Académie of Strasburg, broken up in 1870 by the war, was replaced by the new University by virtue of a decree issued from the Chancelry of the German Empire, under date of December 11th, 1871—the same day on weich the additional convention of the treaty of peace was signed at Frankfort. This decree entrusted the organisation of the teaching staff to M. von Roggenbach, formerly Minister of the Grand Duchy of Baden. From

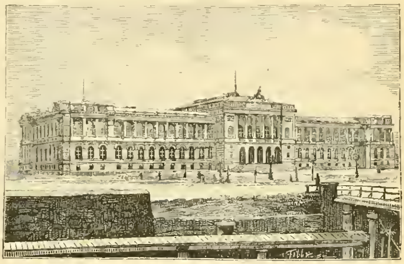


Fig. 1.—University of Strasburg: The Collegiate Palace.

the summer semester of 1872 onwards a body of forty-two professors constituted the staff. They began their work on May 1st of that year, being the three hundred and fifth anniversary of the opening of the Académie, which was founded May 1st, 1567, by the Stattmeister Johann Sturm von Sturmeck. At the present time the new University of Strasburg counts seventy-three ordinary and nineteen extraordinary professors, who during the summer semester of the year 1884, have conducted in the five faculties no fewer than 242 courses of lectures and classes. The work is thus distributed between the five faculties:

Fac lty.	Professors.	Classes and Lectures.
Theology	7	26
Law and Political Sciences	12	29
Medicine	26	60
Philosophy	25	77
Natural Sciences & Mathematics	22	50

Side by side with the laboratories and hospitals attached to each special branch of the natural and medical sciences, there exist the seminaries appropriate to the other branches of learning duly equipped for the purpose of initiating the student into the real work of his subject. A fine library of 560,000 volumes, and a reading-room furnished with 571 periodicals, reviews, and journals, are fitted up in the ancient episcopal residence or château, for the use of both pupils and masters. At the beginning of

the year 1884 the University counted 858 matriculated students, of whom but 266 were from Alsace-Lorraine. We may complete these statistical details by recalling how, since the annexation, the sum devoted to the outfit of the University of Strasburg has amounted to 16,000,000 francs (£640,000), without reckoning the value of the establishments of the ancient Académie, or the cost of the library, which was 1,785,000 francs (£71,400). There is also an annual endowment of 1,087,227 francs (£43,000) for the maintenance of the University, and one of 150,000 francs (£6,000) for that of the library, both charged to the Imperial budget, to meet the current necessities, in addition to the income derived from older special endowments.

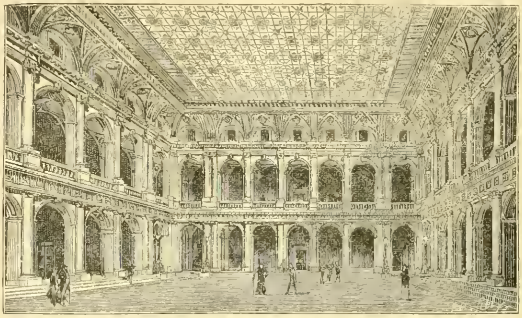


FIG. 2—The Collegiate Palace: Salle des Pas-Perdus.

The cuts which illustrate the different establishments of the University, and which convey better than any mere description some faint sense of the scale on which this work has been done, and for which we have to thank the kind attention of M. Schricker, secretary of the Senate of the University, were prepared from photographs taken to accompany a memorial document published at Strasburg in 1884 entitled *Festschrift zur Einweihung der Neubauten der Kaiser-Wilhelms Universität.* The buildings at present finished are spread in two great groups around the civil hospital and in the new quarter of the town now rising between the Promenade des Contades and the Porte des Pêcheurs; the latter being outside the line of fortifications demolished in 1871. It may be remembered that Strasburg now covers within its new fortifications an area thrice as great as that of the old city before its

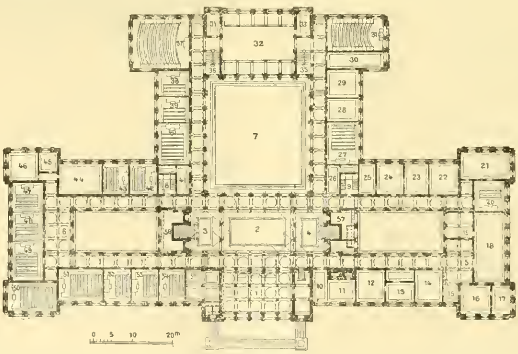


FIG. 3.—The Collegiate Palace: Plan of Ground Floor.—1, Entry.—2, 3, 4, Central Gallery.—5, 6, Corridors.—7, Salle des Pas-Perdus.—8, 9, Side Staircases. 10, 11, University Counting House.—12, 13, Rooms for Meetings of Faculties.—14, Rector's Room.—15, Rector's Antechamber.—16, Secretary of the University.—17, Secretary of the Senate—18, Senate Hall.—19, Antechamber of Senate.—20, Room for Musical reunions.—21, Music Hall.—22, Curator's Office—23, Secretary of Curator.—24, Curator's Room.—25, Curator's Antechamber.—26, Store Room.—27, Class Room.—28 to 30, Theological Seminary.—31, Class Room.—32, Reading Room.—33, Ante-room.—34, Cloak-room—37 to 40, Lecture and Class Rooms.—41, Store Room.—42, 43, Class Rooms.—44 to 46, Seminary of Mathematics.—47 to 54, Lecture and Class Room.—55, Professor's Parlour.—56, 57, Lavatories, &c.—58, Janitor.

annexation to Germany; and its population was 104,000 at the census of 1880.

It will take you half-an-hour to walk from the medical institutes, grouped around the square of the civil hospital, across the old streets, which still preserve the primitive appearance and the characteristic marks of mediæval German cities, to the new collegiate palace. As you cross from the Kaiserplatz towards the Ill, there rises before you the façade of the collegiate palace, built in sandstone from the Vosges (Fig. 1). This is, properly speaking, the chief building of the University, the various institutes being so many annexes. The palace is a very fine building, in the style of the Renaissance, with simple lines, standing behind a square with fountains and gardens. The plan is of an

inverted **T** shape, giving a frontage of 410 feet in length to the façade. The two lateral wings and the central member are thrown forward a little and rise slightly above the rest of the building. A fine external flight of steps leads into the interior. The basement is of red sandstone; the two stories of grey. Over the five entrance porches stand five Corinthian columns supporting a frieze, and surmounted by a group of five sculptured figures, considerably above life-size. Pallas Athene, protectress of science, stands before her throne in a calm and solemn attitude, holding up her torch in her right hand, and lowering a crown in her left. On the two sides of the throne the personifications of philosophy and natural science are each occupied in teaching a young man who reclines at their respective feet. One of these youths endeavours to raise a veil from a sphinx, under the direction of the elder muse, whilst the younger sister, with compass and crystal explains to her scholar a scientific

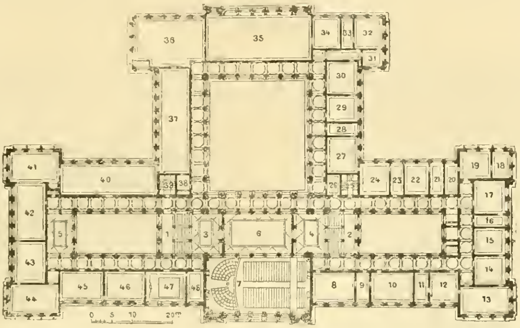


FIG. 4.—The Collegiate Palace: First Floor.—1, 2, Chief Staircases.—3, 4, Vestibules.—5, Corridor.—6, Vestibule of the Theatre.—7, The Theatre.—8. Roman Seminary.—9, Director's Cabinet.—10. English Seminary.—11 to 13, Philological Seminary.—14, 15, Institute of Archæology.—16, 17, Seminary of German Philology.—18 to 20, Seminary of Geography.—21, 22, Seminary of Philosophy.—23, 24, Seminary of Modern History.—25, Staircase.—26, Servants.—27, 28, Seminary of Mediæval History.—29, 30, Seminary of Jurisprudence.—31 to 33, Seminary of Political Science.—34, 38, 40, 42, 45, Institute of History of Ancient Art.—39, Staircase.—43, Hall of Egyptology.—44 to 47, Institute and Lecture Hall for History of Art.—48, Library of this Institute.

problem. Under the group is the inscription in Roman letters: LITTERIS ET PATRIÆ. In five niches under the windows of the upper floor, and between the five columns, are five bronze busts, representing the five faculties in the persons of Saint Paul, Solon, Aristotle, Hippocrates, and Archimedes. Two other niches on the right and left of the five columns contain female statues personifying Strasburg and Germany. There are also thirty-six stone statues at the angles of the building. As will be seen from the plans (Figs. 3 and 4) the central block and each ments and the class rooms in the wings. The seminaries of the faculty of philosophy and the collections of archæology and historical art are placed, along with the aula or great theatre on the higher storey. The plans were drawn by Prof. Warth of Carlsruhe, who also directed the works of construction from 1874 to 1884.

The official rooms of the secretary and of the rector, spacious in proportion, occupy the south wing of the ground floor, along with the senate hall and the music hall: for musical science enters also into the curriculum

FIG. 5.—The Institute of Chemistry.

FIG. 6.—The Institute of Physics.

of the wings encloses an internal court. The central court is glazed, and constitutes an enormous hall, the Salle des Pas Perdus (Fig. 2), 92 feet long, 82 feet wide, and $52\frac{1}{2}$ feet high. The galleries of the upper floor open upon this hall, which is lighted exclusively from the top. The inauguration ceremony was held in this hall. All official notices are posted here or in the side alleys. In allocating the various rooms of the building the architect placed on the lower storey the offices of the administrative depart- of the University. In the richly decorated hall for meetings of the senate the ceiling is particularly noticeable. On the left of the entrance in the north wing of the ground floor the corridors lead to the professor's parlour and to the lecture-rooms of the various faculties. These lecture-rooms contain altogether 963 seats, varying in individual rooms according to the varying requirements from 27 to 208 places. With the exception of two, the seminaries for practical studies are placed on the higher floors, so as

to be quiet enough for their purpose. They are open either all day or during certain hours, under the superintendence or direction of the professors, who each have their own private room beside the room allotted to students.

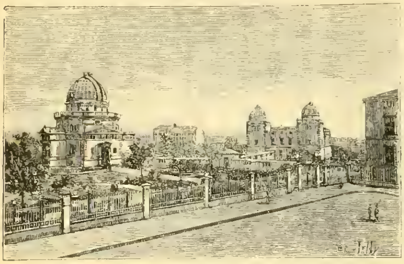


Fig. 7.—The Astronomical Observatory.

These seminaries correspond in their particular line to the laboratories of the faculty of natural science; and they provide for students' collections, appliances and special libraries for each branch of instruction. Placed side by

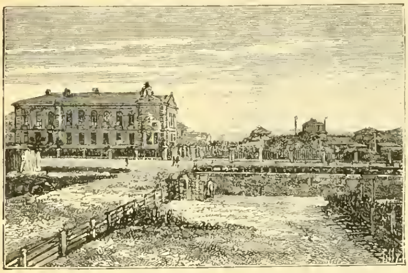


Fig. 8.—The Institute of Botany.

side along the corridors they are each readily accessible to members of neighbouring seminaries. Starting from the middle of the principal building there are successively the seminaries of the Romanesque languages and of

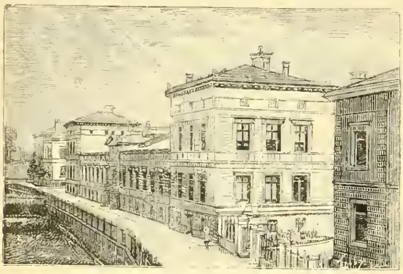


Fig. 9.—The Institute of Anatomy and Pathology.

English, the philological seminary, the institute of archæology, the German seminary, the seminaries of historical science, of philosophy, of jurisprudence, and of political science. All the northern half of the first floor is devoted to art collections, extending from the seminary of political science to the aula or great theatre. In the middle of the western façade is the common lecture hall, flanked on the one side by the library of the institute of archæology, on the other by the rooms of the institute of historical art. A particular hall is reserved for temporary exhibitions. Then comes the hall of Egyptology and the archæological museum organised with as much taste as science by M. Michaelis, the professor of archæology. Egyptology and Arabic have each a special professor.

Beside the seminaries and the art collections the principal floor contains the aula or festival theatre, for the

Fig. 10.—The Surgical Clinical Hospital.

University commemorations. Lit from above this hall occupies the middle of the front façade, and is approached at both ends by the grand staircases. Five open arcades separate the aula from an exterior room reserved for the public. The theatre itself is 82 feet long, $47\frac{1}{2}$ wide, and 33 high. It seats 450 persons, whilst the external chamber admits of 200 to 300 standing places. The decorations are in plaster, and there is a bust of the Kaiser Wilhelm against the northern wall in white marble.

The heating arrangements—partly hot air, partly hot water—are in the basement, a combined system being used for the class-rooms, hot air alone for the corridors

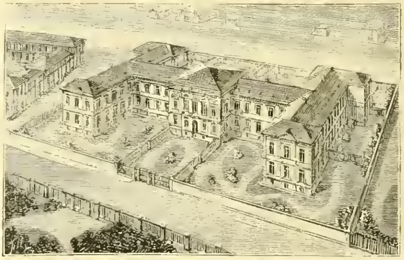


Fig. 11.—The Clinical Hospital for Mental Disorders

and for the great hall. The ventilation is operated by gas engines. All the windows are double glazed to obviate too rapid cooling. No scientific appliance has been forgotten which might secure good sanitation. The aula, the rector's apartments, the staircases, and the Salle des Pas Perdus are richly ornamented in plaster and with painting. The lecture halls and class rooms are more simple and severe as befits their purpose, but for that very reason nothing has been omitted to give them a solid and almost monumental construction. Sandstone relieved with marble prevails in the interior; whilst the floors of the vestibules and corridors are of mosaic and terrazo.

Each of the special institutes of chemistry, physics, botany, pharmacy, and astronomy, which are grouped behind the collegiate palace, merit a particular description, as well as the hospitals of surgery, obstetrics, and psychiatry, and the institutes of anatomy, physiological chemistry, and of physiology belonging to the faculty of medicine, which are grouped around the civil hospital. Views of these are given in Figs. 5 to 15. Each of these institutes is independent and separate from the others, provided with everything appropriate to its specific purpose. In order to enable the professors, who are the directors of the special institutes, to follow fully the work of the students and the practice of the laboratory, they are provided with residential apartments in the same buildings. To the institute of astronomy is added an astronomical observatory. This is at the present time directed by Dr. Schur, in consequence of the protracted illness of Prof. Winnecke, who was assistant at the observatory of Pulkowa before coming to Strasburg. At the institute of botany, Prof. von Bary, whose work on cryptogamic flora is well known, has laid out a new botanic garden, to which a second hothouse is yet to be added. To complete the organisation of the University establishments there remain to be erected an institute of geology, an institute of zoology, and an institute of meteorology. The institute of geology, to be directed by Prof. Benecke, will receive the mineralogical and palæontological collections, and at the same time will accommodate the work of the geological survey of Alsace-Lorraine. As to the institute of meteorology, its utility has been already admitted by the provincial government, and its establishment is only a question of time.

Fig. 12.—The Maternity Hospital.

Fig. 13.—The Institute of Physiological Chemistry.

Toward the sum of 16,000,000 of francs (£640,000) expended up to this year on the new University of Strasburg the German Empire has contributed the sum of 3,800,000 marks, or 4,750,000 francs (£190,000); and of this sum 2,875,000 francs (£115,000) were spent on the collegiate palace. The institute of chemistry alone cost 875,000 francs (£35,000); the institute of physics, 728,750 francs (£29,150); the institute of botany with its garden, 655,000 francs (£26,200); the astronomical observatory, 642,000 francs (£25,600); the institute of anatomy, 1,048,500 francs (£41,740); the surgical clinical hospital, 662,500 frans (£26,500); the institute of physiological chemistry, 400,000 francs (£16,000); the institute of physiology, 337,500 francs (£13,500). It is impossible to give here the details of each institute. Suffice it that each establishment has profited by the latest advances of science, and provides every means of research to students. Henceforth the institutes annexed to the University of Strasburg will serve as models for the installation of similar buildings. They are not only most complete, but are already sought by students. Thus the institute of chemistry, under the direction of Prof. Fittig, is designed to receive 100 students in its two divisions of organic and inorganic chemistry; and there is not a single vacant place. Further information respecting the various institutes and their organisation can be learned from the *Festschrift*, already alluded to as having been written by M. Schricker to commemorate the opening. As the great library of the country has been but temporarily housed in the episcopal château near the Cathedral (in consequence of the fire during the bombardment of 1870) it is intended to remove it to the neighbourhood of the collegial palace of the University. At present, beside the special libraries of the several seminaries, there is only one reading-room (Fig. 3, No. 32) for periodicals and reviews.

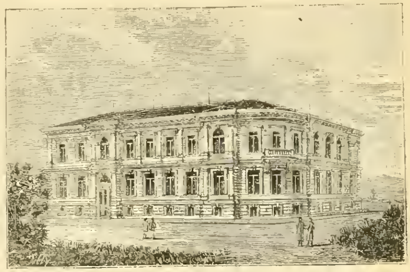


Fig. 14.—The Institute of Pharmacy.

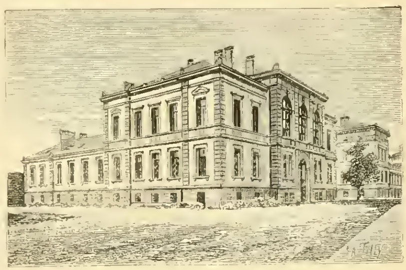


Fig. 15.—The Institute of Physiology.

Down to the present time the native Alsatians and Lorrainers have not frequented the new university as much as might have been expected in proportion to the needs of the province. Young men still turn towards France to follow their studies for the professions at Paris or at

Nancy. Meantime the recruiting of lawyers and doctors goes on at Strasburg with foreign elements, not without some regret on the part of the native inhabitants. But little by little the force of circumstances is tending to bring the young Alsatians to constitute the University of Strasburg in spite of sentiment. Instead of 69 students, natives of Alsace-Lorraine, registered in 1872, the University registers showed 252 in 1884—a notable increase. As against 5,990 matriculated students at the University of Berlin, 3,399 at Leipzig, 2,276 at Munich, 1,646 at Breslau, 1,452 at Halle, 723 at Heidelberg, 625 at Freiburg, there were to be reckoned but 858 at Strasburg during the summer semester of 1884. No doubt this number will increase rapidly; for in no other centre of the higher education are the means of work so abundantly provided. As to the professorial staff, it includes many celebrities, amongst whom may be named Labaud in the faculty of law; Reuss in the faculty of theology; Brentano, Krapp, and Merkel in political science; Kussmaul, Lucke, and Recklingshausen in the faculty of medicine; Gerland, Michaelis, and Studemond in the faculty of philosophy; Kundt, Benecke, von Bary, and Fittig in the faculty of natural sciences. In selecting these names we do not forget the glory of the former university of the last century, when Strasburg had amongst the number of its celebrities Profs. Blessig, Lauth, Schœpflin, Schweighæuser, Oberlin, worthy predecessors of the Duvernoys, Schimpers, Gerhardts, Pasteurs, Daubrées, Sédillots, Janets, Fustels, Coulanges, Forgets, and Kusses of our time. On August 6th, 1771, Goethe graduated doctor of laws of the University of Strasburg, with a thesis on the respective rights of State and Church. If to-day the new University has as an accessory function that of contributing to the Germanisation of the annexed provinces, it may at least be said that the staff of professors of the older university of last century had rallied to French politics in the most open manner. Witness the address to King Louis XV. dated October 6th, 1744:—"Sire, the most faithful of the universities in your kingdom offers to your Majesty its homage and its good wishes. Penetrated with joy at the convalescence and at the arrival of its august monarch, it to-day, Sire, finds united in you the father of the people, the protector of the muses, the liberator of Alsace, and the hero. It is to these glorifications of your rare virtues, great king, that we consecrate our work, happy if our words may correspond to the effusion of our hearts, and merit the continuation of the good graces of the most puissant and most beloved of the sovereigns of Europe."

Formerly the Académie of Strasburg took up the special task of serving as an intermediary between France and Germany for the propagation of ideas and of the scientific movement. More richly endowed, the new University, applying its greater powers to the development of the human mind, will recognise that the representatives of the people of Alsace-Lorraine have wished to promote its efforts in the largest and most generous manner in the higher interests of science. Science ought to contribute to the union of the people; it has no exclusive national character, and it serves to advance the reign of peace in the world by assuring to us greater prosperity and greater light, whilst developing in us all the love of our own country.

NOTES

The Royal Medals of the Royal Geographical Society will this year be awarded to Mr. Joseph Thomson and Mr. H. E. O'Neill—to the former for his well-known work in Africa, and to the latter for his thirteen journeys of exploration along the coast and in the interior of Mozambique. The Murchison Grant for 1885 will be awarded to the Pandit Kreshna for his four explorations made while attached to the Survey of India, and especially for his extensive and important journey in the interior of Tibet. The Back Grant goes to Mr. W. O. Hodkinson for his Australian explorations, and the Cuthbert Peek Grant to Mr. J. T. Last for his surveys and ethnological researches in the Southern Masai, Nguru, and other neighbouring countries. The following will be made Honorary Corresponding Members:—Chief-Justice Daly, President of the Geographical Society of New York; M. Elisée Reclus, the eminent geographer; and Herr Moritz von Déchy, the distinguished Austrian explorer of the Sikkim Himalayas, the Caucasus, and other regions.

It is announced that the next meeting of the American Association for the Advancement of Science will be held on August 26 and following days, at Ann Arbor, Mich.

At the annual conference of the French learned societies, which met on the 8th inst. in Paris, MM. Faye, Mascart, and Darboux, were appointed president and vice-presidents respectively of the section for the mathematical and physical sciences; and MM. de Quatrefages, Milne-Edwards, and Maunoir to the same offices in the section for geographical and natural sciences.

M. Hervé-Mangon, the new French Minister of Agriculture, is a Member of the Academy of Sciences in the Section of Rural Economy and a Professor of Agronomy to the Conservatoire des Arts et Métiers. He was for some time a Director of the establishment, but resigned in order to secure a seat in the French Lower House. He married the daughter of the late M. Dumas.

The next Ordinary General Meeting of the Institution of Mechanical Engineers will be held on Thursday, April 30, and Friday, May 1, at 25, Great George Street, Westminster. The chair will be taken by the President, Mr. Jeremiah Head, at half-past three o'clock p.m. on Thursday, and at half-past seven o'clock p.m. on Friday. The following papers will be read and discussed, as far as time will admit:—Description of the Maxim automatic machine-gun, by Mr. Hiram S. Maxim, of London; Abstract of results of experiments on riveted joints, with their applications to practical work, by Prof. Alexander B. W. Kennedy, of London (including the latest experiments described in Prof. Kennedy's Report, issued to the members in February); Description of the Tripier Spherical Eccentric, by M. Louis Poillon, of Paris; Description of a blooming mill with balanced top roll at the Ebbw Vale Works, by Mr. Calvert B. Holland, of Ebbw Vale.

The Annual Report of the French Central Meteorological Department states that the weather forecasts last year were verified in 90 cases out of every 100, the percentage having steadily risen from 81 in 1881 to 83 in 1882 and to 87 in 1883. Out of 189 alarm signals sent to the ports, 128 were fully verified, 24 were fairly correct, 37 incorrect, and only two gales were not foreseen. This year the gale of January 11 was foretold, but that of March 22, which did such damage at Cherbourg, was not predicted. It took place in exceptional circumstances, and was of short duration.

During the second half of last year several communications appeared in Nature relating to the nests from which the Chinese birds'-nest soup is made. Mr. Pryer, whose account of his visits to the Gomantin Caves in North Borneo, where the nests are chiefly found, initiated the discussion, has now addressed a long communication on the subject to an English journal published in Japan, the main points of which appear to be as follows:—(1) Owing to a misapprehension, Mr. Pryer was represented as saying that the bats which inhabit the caves constructed the nests as well as the swifts. The bats have nothing to do with the nests. (2) Mr. Layard, in his letter published in Nature (November 27, 1884), speaks of "traces of blood, from the efforts of the birds to produce the saliva." Mr.

Pryer thinks that the patches of brown-red on the nests may be due to blood from the hands of the gatherers, or to the betel-juice which they constantly expectorate, but not to the bird's blood. (3) The birds do not eat algæ; they are purely insectivorous. (4) Mr. Green says (NATURE, December 11) that a chemical and microscopical examination of the nests suggests that they are made from the saliva of the bird. This Mr. Pryer regards as a physical impossibility, for the bird could not secrete in a few days a mass of saliva more than equal, when dried, to the entire bulk of its own body, and then do this nine consecutive times a year. He thinks that, undoubtedly, some saliva is used by the birds, the algæ (which Mr. Pryer incorrectly called "fungoid growth" in his first account) being used in the same way as a Japanese swallow (*Cecropis japonica*) uses mud. This bird gathers pellets of mud and works them up in its mouth, forming a strong cement, constructing a large bottle-shaped nest, sometimes nearly two feet long; and exactly as the *Cecropis japonica* uses mud, so the Bornean *Collocalia fuciphaga* uses algæ, producing thereby the delicate structure known as edible bird's nest. Besides, Mr. Pryer states that the nest examined by Mr. Green was probably not genuine, as the substance is very easily imitated, and the high price would stimulate adulteration. (5) His previous theory that the distinction between white and black nests is due to the brown outside of the algæ being used for the latter, he now renounces. The birds can only use the inside, and black nests are simply white nests grown old and repaired frequently. The difference is not due to any difference in the site or in the kind of bird. This is the writer's present theory. Owing to some accident (a native printer's mishap possibly), portions of Mr. Pryer's paper are not quite coherent and connected, and some of the words and phrases are misplaced with that ingenious absurdity so characteristic of printers' blunders; but we believe we have given the substance of the communication here.

THE sixteenth annual report of the American Museum of Natural History has just been published. Besides various additions to the collections during the year—the principal being 44 specimens of North American birds, 29 specimens of North American mammals, and 20 monkeys—the trustees report a step of great importance taken in creating a section in the museum called "The Department of Public Instruction." The Legislature of the State of New York having appropriated a sum to enable the curators of the museum to give free lectures, illustrated by its collections, to the teachers of common and normal schools throughout the State, the trustees have accepted the duty, and have arranged for a series of lectures extending over four years, twenty in each year, all to be richly illustrated with original views and drawings specially prepared for the course. The curriculum for the first course 1884-85 includes human anatomy and physiology, forestry, building and ornamental stones, and the animal kingdom.

MR. J. A. ALLEN, who for many years has had charge of mammals and birds at the Museum of Comparative Zoology at Cambridge, has, *Science* states, accepted the curatorship of mammalogy and ornithology in the American Museum of Natural History in New York, where he will enter upon his new duties about May 1.

THE American Government have sent 30,000 land-locked salmon to the National Fish Culture Association, which arrived on Saturday in excellent condition. In this country the hybridisation of the various species of Salmonidæ is extensively prosecuted; and it is proposed to try the experiment of cross-breeding the land-locked salmon with the brook trout or char, thus promoting the culture of a better class of fish than the trout which now abound in our rivers.

DR. H. J. JOHNSTON-LAVIS, of Naples, announces the approaching publication of a "Monograph of the Earthquakes of Ischia," a memoir dealing with the seismic disturbances in that island from remotest to recent times, with special observations on those of 1881 and 1883, by himself, with some calculations by Rev. Prof. Samuel Haughton, M.D., F.R.S., F.G.S., &c. The work will be published by subscription, and intending subscribers should communicate with the author, 7, Chiatamone, Naples.

A SHARP shock of earthquake was felt in Rome on the night of the 9th inst. Bells were set ringing, and many persons were momentarily alarmed by the movement, but that was the extent of its effect. Prof. Stefano Michele de Rossi has communicated the following report to the Press:—"At 2.44 a.m. a distinct shock of earthquake aroused a great part of the population of Rome. From the observations obtained it belonged to the sixth degree of the conventional scale of 10 degrees for intensity. It undulated from south-west to north-east, and then from north-west to south-east. The full duration was about 10 seconds, of which four were occupied by the second phase of the phenomenon. A telegram from Avezzano states that the shock was very strong there in the direction of north to south. No damage done." Telegrams received later from Frosinone report that a shock was felt there at the same time with sufficient force to create general alarm among the population.

THERE has been a renewal of earthquake shocks in the provinces of Granada and Malaga. Early on the morning of the 11th oscillations of more or less violence are reported from Velez Malaga, Antequera, Motril, and the city of Granada itself and some surrounding villages. So far as is known there has been no loss of life or serious damage, but the panic at some places is described as intense, and the inhabitants, refusing to return to their houses, remain in the open country.

SEVERAL shocks of earthquake were felt at Geneva on the 13th.

THE most recent contribution to the much-discussed question of the origin of the mound-builders of the United States is a pamphlet by Mr. C. E. Putnam, issued by the Academy of Natural Sciences of Davenport, Iowa. The Bureau of Ethnology connected with the Smithsonian Institute champions the theory that the race which constructed these mounds may be traced to the ancestors of the present American Indians, while another school of archæologists holds that the mound-builders were more advanced in civilisation than the American Indians, and have endeavoured to trace them to a Mexican origin, or to some common ancestry. This being the broad question at issue, the Davenport Academy, which appears to have adopted no theory on the subject, became possessors by donation of three inscribed tablets and two elephant pipes, *i.e.* pipes with the figure of an elephant carved on them, which are stated to have been found in Iowa. In the words of Mr. Putnam, "if their authenticity is established, then archæologists will find in them strong corroborative evidence that man and the mastodon were contemporary on the American continent, and the mound-builders were a race anterior to the ancestors of the present American Indians, and of higher type and more advanced civilisation." But doubts have been cast on the authenticity of these curious relics by the Bureau of Ethnology, and the Davenport Academy has taken the matter up with some warmth. Mr. Putnam's pamphlet is the Academy's reply, and is a vigorous defence of the genuineness of the elephant pipes and inscribed tablets. It describes in detail the circumstances under which they were discovered, the witnesses present, &c., and lays especial stress on the fact that the two pipes were dug up at different times and places, by independent persons, one, at least, of whom had no notion of the value of the object. The whole subject is one of extraordinary interest, and Mr. Putnam's statement, vouched as it is by a formal resolution of the Davenport Academy, must play an important part in any

subsequent discussion as to the value to be attached to these remains, which, if authentic, are acknowledged to have much influence on the final settlement of the question as to who the mound-builders were.

THE use of artificial teeth is not so modern as is generally believed. *Cosmos* states that in the museum of Corneto, on the coast of Italy, there are two curious specimens of artificial teeth found in Etruscan tombs probably dating to four or five centuries before our era. These graves contained the bodies of two young girls. On the jaw of one is still to be seen two incisors fixed to their neighbours by small gold rings; in the other the rings remained, but the artificial teeth had fallen out. The teeth, carefully cut, had evidently been taken from the mouth of some large animal. The dentist's art amongst the ancients was not confined to drawing teeth, and replacing them by artificial ones, for natural teeth have been found which have evidently been treated in various ways. That this curious fact has escaped notice so long, is due to the rarity of Etruscan skeletons, the Etruscans employing cremation generally, and also to the circumstance that modern inquirers are more interested in objects of Etruscan art and industry than in the remains of their ancient owners.

WE have received from the Rev. H. H. Higgins the reprint of a paper read by him before the Literary and Philosophical Society of Liverpool on Museums of Natural History. The writer discusses the subject under four heads, to which a fifth, on the British Museum of Natural History, is added. These are Museum visitors' desiderata, arrangements and appliances. Judging from the attendance at the Liverpool Museum, he calculates that a large majority (about 780 in 1000) of the visitors are those who are not conscious of any purpose beyond a wish to see the Museum, but who fix their attention with more or less intelligence on the objects displayed. The students would number about ten to twenty, and loungers, including children, 200 in the thousand. The first desideratum in a public museum is a better treatment of the specimens which they already possess. The Museum, Mr. Higgins thinks, is a rare one, in which a donation of 100*l.* could *best* be spent in the purchase of fresh specimens; in almost all instances it could be better spent in making the order more intelligible and more instructive, and much of this good work might be done without spending any money. The sections on arrangements and appliances contain many interesting suggestions on these important elements in the success of a museum. A *stammbaum*, or phylogenetic scheme of the pedigree of animals and vegetables, by Prof. Herdman, of University College, Liverpool, is added to Mr. Higgins's paper.

WE have received Dr. Howden's presidential address to the Montrose Scientific and Field Club, on the "Aims of a Naturalists' Field Club," which contains much useful advice as to the methods in which the members of such societies should regulate their studies and researches. What has already been done in local natural history in the vicinity of Montrose and suggestions as to what still lies ready at hand to be done, are described in the concluding portion of the address.

Timber, a weekly journal devoted to the timber and kindred interests, is the title of a new journal, the first number of which appeared on February 28. A large portion of this periodical is occupied with trade announcements and records of sales, with a sprinkling of short articles and paragraphs on subjects connected with the uses of timber or the timber supply. The paper is intended for circulation among, and as the representative of, the numerous trades who work in timber, and does not profess to be anything else.

THE experiments in Paris by the Triboulet system of photographing all the country seen from a captive balloon by opening the valve of a panoramic object-glass with a current sent from the ground has succeeded wonderfully well. As the operators remain on the ground a very small balloon is sufficient to carry the photographic apparatus. The impressions being taken on films can be inspected with a microscope, and are useful for military purposes.

THE additions to the Zoological Society's Gardens during the past week include a Pig-tailed Monkey (*Macacus nemestrinus* ♀) from Java, presented by Mrs. Urquhart; a Chinese Mynah (*Acridotheres cristatellus*) from China, presented by Mr. George Rowler; a Galeated Curassow (*Pauxis galeata* ♂) from Venezuela, presented by Mr. G. A. Crawley; a Chilian Sea Eagle (*Geranoaetus melanoleucus*) from Chili, presented by Mr. Richard J. Jones; a Carrion Crow (*Corvus corone*), British, presented by Mr. A. Browning Priestley; a Smooth Snake (*Coronella lævis*) from Hampshire, presented by Mr. W. H. B. Pain; a Tibetan Wild Ass, or Kiang (*Equus hemionus* ♀) from Tibet, four Sonnerat's Jungle Fowls (*Gallus sonnerati* ♂ ♂ ♀ ♀) from Southern India, deposited; a Mandarin Duck (*Æx galericulata* ♂) from China, a Dark Green Snake (*Zamenis atrovirens*), South European, purchased; two Rendall's Guinea Fowls (*Numida rendalli*) from East Africa, received in exchange; a Gigantic Salamander (*Megalobactrachus giganteus*) from Japan, two Bull Frogs (*Rana catesbiana*) from North America, received on approval; a White-fronted Lemur (*Lemur albifrons*), born in the Gardens.

GEOGRAPHICAL NOTES

MR. WADA, of the Japanese Legation in Berlin, recently laid before the Geographical Society there certain maps produced by the Geological Survey of Japan, which represent the work up to the present of that establishment. It was founded in 1879, and was organised by Dr. Naumann, a German geologist. It consists of topographical, geological, and agrenomical sections, and of a technical and chemical laboratory. The maps prepared by the department for the Geological Congress of Berlin this year were:—(1) An oroplastic map, on a scale of 1 : 860,000, showing the general position and form of the Japanese archipelago, the coasts, ranges of mountains, as well as the depths of the ocean off the coast. (2) A magnetic map. During the preliminary topographical survey magnetic variations were investigated by the help of a portable magnetometer. Magnetic investigations are of extraordinary interest in Japan. The maps show that the variations are frequently very different in kind, the numerous volcanoes causing great irregularity. (3) A geological map constructed from the preliminary surveys of Dr. Naumann and native geologists. This is based on a topographical map, which is not reliable in detail; but it shows the knowledge attained so far of the geological structure of Japan. From this it appears that all the formations are met with in that country, the Palæozoic being universal. Next to these in extent comes granite. A complete report on this subject is to be made by the head of the Survey to the Congress. The topographers have worked now for about four years, and the area surveyed is more than eighty geographical miles square. The completion of the maps for the whole country will take another eight years. The detailed geological survey has reached about the same extent as the topographical survey, but none of the sheets of the map have yet been published, although they exist in manuscript down to the 38th parallel, with the exception of Yezo. The maps, as well as the text, appear in Japanese and English, and the Survey publishes also annual reports, eight of which have already appeared, but only in Japanese. Another map, also prepared for the Congress, is one of the volcanoes, the ages being distinguished by colours. An important portion of the work of the Survey is the study of soils. According to Mr. Wada, a volcanic tufa, consisting for the most part of decomposed silicates, forms a large part of the numerous uncultivated plains at the foot of the mountains. An accurate knowledge of this will be of much value to agriculture. Japanese soils in general are stated to be poor in chalk. This subject will also be dealt with by the head of the Agronomical Section before the forthcoming Congress.

The last *Bulletin de la Société de Géographie* (1[er] Trimestre, 1885), contains a paper by M. de Mailly-Chalon on a journey in Manchuria. With two countrymen he left Peking for Newchwang, and thence passing to the east of Moukden, through Kirin to Ninguta, where the party turned to the south-east along the Tiumen, towards the ocean, and reached Vladivostock. The journey the whole way was along the Corean frontier. Leaving Vladivostock the travellers crossed Siberia to Tomsk, from which they went to Samarkand. From this point the story of the journey is taken up by another member of the party, Baron Benoist-Méchin, whose paper on the journey across Turkestan succeeds M. Mailly-Chalon's. This journey led them from Samarkand through Karshi, to Bokhara, thence to the Amou-Darya at Charjui. They followed the river then down to Petro-Alexandrovsk, whence they deviated to Khiva. From the latter town they retraced their steps up the river, and from Kurgan-Chin started across the Kara-Kum to Merv, and so to Sarakhs and Persian territory at Meshed. The journey, here barely indicated, lasted two years, *i.e.* from the departure from Japan for Peking to the arrival in Teheran. M. Rabot writes on Nordenskjöld's expedition to Greenland, the paper being compiled from the Professor's reports to Mr. Oscar Dickson, published in the *Journal* of the Swedish Society of Anthropology and Geography. M. Charles Huber brings to an end his long journeys in Central Arabia, between 1878 and 1882, to which we have adverted in noticing previous numbers of the *Bulletin.*

At the meeting of the Paris Geographical Society on the 7th inst., M. Giraud was received with great distinction, and detailed his recent travels in Africa. The explorer has received the gold medal of the Society and the Cross of the Legion of Honour.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *APRIL* 19-25

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on April 19

Sun rises, 4h. 57m.; souths, 11h. 59m. 0·7s.; sets, 19h. 1m.; decl. on meridian, 11° 20′ N.: Sidereal Time at Sunset, 8h. 53m.

Moon (at First Quarter on April 21) rises, 8h. 10m.; souths, 16h. 4m.; sets, 23h. 58m.; decl. on meridian, 18° 14′ N.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury ...	5 4 ...	12 44 ...	20 24 ...	18 2 N.
Venus ...	4 57 ...	11 45 ..	18 34 ...	8 47 N.
Mars ...	4 36 ...	11 7 ...	17 38 ...	5 21 N.
Jupiter ...	12 45 ...	20 2 ...	3 19* ...	14 3 N.
Saturn ...	7 22 ...	15 28 ...	23 34 ...	22 3 N.

* Indicates that the setting is that of the following day.

Occultations of Stars by the Moon

April	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
20 ...	λ Geminorum ..	3½ ...	22 59 ...	23 20 ...	187 232
22 ...	B.A.C. 3122 ...	6½ ...	21 4 ...	22 4 ...	127 255
23 ...	π Leonis	5 ...	18 46 ...	19 42 ...	14 290
24 ...	*d* Leonis	5 ...	23 7 ...	23 58 ...	135 238

Phenomena of Jupiter's Satellites

April	h. m.		April	h. m.	
20 ...	1 12	I. tr. ing.	22 ...	2 24	III. occ. disap.
	22 19	I. occ. disap.		20 14	I. ecl. reap.
21 ...	1 45	I. ecl. reap.	23 ...	2 28	II. occ. disap.
	19 39	I. tr. ing.	24 ...	20 34	II. tr. ing.
	21 59	I. tr. egr.		23 30	II. tr. egr.
			25 ...	19 55	III. tr. egr.

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

April	h.	
19 ...	1 ...	Saturn in conjunction with and 4° 1′ north of the Moon.
22 ..	3 ..	Jupiter stationary.
23 ..	19 ...	Jupiter in conjunction with and 4° 37′ north of the Moon.

ON A REMARKABLE PHENOMENON OF CRYSTALLINE REFLECTION[1]

Introduction.

In a letter to me, dated March 29, 1854, the late Dr. W. Bird Herepath enclosed for me some iridescent crystals of chlorate of potash, which he thought were worth my examination. He noticed the intense brilliancy of the colour of the reflected light, the change of tint with the angle of incidence, and the apparent absence of polarisation in the colour seen by reflection.

The crystals were thin and fragile, and rather small. I did not see how the colour was produced, but I took for granted that it must be by some internal reflection, or possibly oblique refraction, at the surfaces of the crystalline plates that the light was polarised and analysed, being modified between polarisation and analysation by passage across the crystalline plate, the normal to which I supposed must be sufficiently near to one of the optic axes to allow colours to be shown, which would require no great proximity, as the plates were very thin. To make out precisely how the colours were produced seemed to promise a very troublesome investigation on account of the thinness and smallness of the crystals: and, supposing that the issue of the investigation would be merely to show in what precise way the phenomenon was brought about by the operation of well-known causes, I did not feel disposed to engage in it, and so the matter dropped.

But more than a year ago Prof. E. J. Mills, F.R.S., was so good as to send me a fine collection of splendidly coloured crystals of the salt of considerable size, several of the plates having an area of a square inch or more, and all of them being thick enough to handle without difficulty. In the course of his letter mentioning the despatch of the crystals, Prof. Mills writes: "They [the coloured crystals] are, I am told, very pure chemically, containing at most 0·1 per cent. foreign matter. They are rarely observed—one or two perhaps now and then in a large crystallisation . . . I have several times noticed that small potassic chlorate crystals, when rapidly forming from a strong solution, show what I suppose to be interference colours; but the fully formed crystals do not show them."

Some time later I was put into communication with Mr. Stanford, of the North British Chemical Works, Glasgow, from which establishment the crystals sent me by Prof. Mills had come. Mr. Stanford obligingly sent me a further supply of these interesting crystals, and was so kind as to offer to try any experiment that I might suggest as to their formation.

On viewing through a direct-vision spectroscope the colours of the crystals which I had just received from Prof. Mills, the first glance at the spectrum showed me that there must be something very strange and unusual about the phenomenon, and determined me to endeavour to make out the cause of the production of these colours. The result of my examination is described in the present paper.

Section I.—*Preliminary Physical Examination.*—1. It will be necessary to premise that chlorate of potash belongs to the oblique system of crystallisation. The fundamental form may be taken as an oblique prism on a rhombic base, the plane bisecting the obtuse dihedral angle of the prism being the plane of symmetry. Rammelsberg denotes the sides of the prism by P, and the base by C, and gives for the inclinations of the faces PP = 104° 22′ and CP = 105° 35′. The face C, which is perpendicular to the plane of symmetry, is so placed as to bring three obtuse plane angles together at two opposite corners of the parallelepiped. The salt usually forms flat, rhombic or hexagonal plates parallel to the C plane, the edges of the rhombus being parallel to the intersections of the P faces by the C plane, and the hexagons being formed from the rhombic plates by truncating the acute angles by faces parallel to the intersection of the C plane by the plane of symmetry.

The plane angles of the rhombic plates, calculated from the numbers given by Rammelsberg, are 100° 56′ and 79° 4′, while the hexagonal plates present end-angles of 100° 56′ and four side-angles of 129° 32′. These angles are sufficiently different to allow in most cases the principal plane of a plate, or even of a fragment of a plate, to be determined at once by inspection. But in any case of doubt it may readily be found without breaking the crystal by examining it in polarised light. There are

[1] Paper read at the Royal Society on March 19 by Prof. G. G. Stokes, M.A., Sec. R.S., Lucasian Professor of Mathematics in the University of Cambridge.

good cleavages parallel to the two P planes and to the C plane. The crystals are very commonly twinned, the twin plane being C.

2. If one of the brilliantly coloured crystals be examined by reflection, and turned around in its own plane, without altering the angle of incidence, the colour disappears twice in a complete revolution. The vanishing positions are those in which the plane of incidence is the plane of symmetry. The colour is perhaps most vivid in a perpendicular plane; but for a very considerable change of azimuth from the perpendicular plane there is little variation in the intensity of the colour. There is no perceptible change of tint, but on approaching the plane of symmetry the colour gets more and more drowned in the white light reflected from the surface.

3. If instead of altering the azimuth of the plane of incidence a plane be chosen which gives vivid colour, and the angle of incidence be altered, the colour changes very materially. If we begin with a small angle the colour begins to appear while the angle of incidence is still quite moderate. What the initial colour is, varies from one crystal to another. As we increase the angle of incidence the colour becomes vivid, at the same time changing, and as we continue to increase the angle the change of colour goes on. The change is always in the order of increasing refrangibility; for example, from red through green to blue. Not unfrequently, however, the initial tint may be green or blue, and on approaching a grazing incidence we may get red or even yellow mixed with the blue, as if a second order of colours were commencing.

4. The colours are not in any way due to absorption; the transmitted light is strictly complementary to the reflected, and whatever is missing in the reflected is found in the transmitted. As in the case of Newton's rings, the reflected tints are much more vivid than the transmitted, though, as will presently appear, for a very different reason.

5. As Dr. Herepath remarked to me long ago, the coloured light is not polarised. It is produced indifferently whether the incident light be common light or light polarised in any plane, and is seen whether the reflected light be viewed directly or through a Nicol's prism turned in any way. The only difference appears to be that if the incident light be polarised, or the reflected light analysed, so as to furnish or retain light polarised perpendicularly to the plane of incidence, the white light reflected from the surface, which to a certain extent masks the coloured light, is more or less got rid of.

6. The character of the spectrum of the reflected light is most remarkable, and was wholly unexpected. A direct-vision hand spectroscope was used in the observations, and the crystal was generally examined in a direction roughly perpendicular to the plane of symmetry; but it is shown well through a wide range of azimuth of the plane of incidence. No two crystals, we may say, are alike as to the spectrum which they show, but there are certain features common to all. The remarkable feature is that there is a pretty narrow band, or it may be a limited portion of the spectrum, but still in general of no great extent, where the light suffers total or all but total reflection. As the ang'e of incidence is increased, these bands move rapidly in the direction of increasing refrangibility, at the same time increasing in width. The character of the spectrum gradually changes as the angle of incidence is increased; for example, a a single band may divide into two or three bands.

The bands are most sharply defined at a moderate angle of incidence. When the angle of incidence is considerably increased, the bands usually get somewhat vague, at least towards the edges.

7. The commonest kind of spectrum, especially in crystals prepared on a small scale, which will be mentioned presently, is one showing only a single bright band; and I will describe at greater length the phenomena presented in this case.

When the angle of incidence is very small, the light reflected from the reflecting surfaces of the crystal shows only a continuous spectrum. As the angle of incidence is increased, while it is still quite moderate a very narrow bright band shows itself in some part of the spectrum. The particular part varies from one crystal to another; it may be anywhere from the extreme red to the extreme violet. It stands out by its greatly superior brightness on the general ground of the continuous spectrum, and when it is fully formed the reflection over the greater part of it appears to be total. The appearance recalls that of a bright band such as the green band seen when a calcium salt, or the orange band seen when a strontium salt, is put into a Bunsen flame. The bright band is frequently accompanied right and left by maxima and minima of illumination, forming bands of altogether subordinate importance as regards their illumination. Sometimes these seem to be absent, and I cannot say whether they are an essential feature of the phenomenon, which sometimes fail to be seen because the structure on which the bands depend is not quite regularly formed, or whether, on the other hand, they are something depending on a different cause.

Disregarding these altogether subordinate bands, and taking account of the mean illumination, it seems as if the brightness of the spectrum for a little way right and left of the bright band were somewhat less than that at a greater distance.

When the main band occurs at either of the faint ends of the spectrum, it is visible, by its superior brightness, in a region which, as regards the continuous spectrum, is too faint to be seen, and thus it appears separated from the continuous spectrum by a dark interval.

When the angle of incidence is increased, the band moves in the direction of increasing refrangibility, and at the same time increases rapidly in breadth. The increase of breadth is far too rapid to be accounted for merely as the result of a different law of separation of the colours, which in a diffraction spectrum would be separated approximately according to the squared reciprocal of the wave-length, while in bands depending on direct interference the phase of illumination would change according to the wave-length.

8. The transmitted light being complementary to the incident, we have a dark band in the transmitted answering to the bright band in the reflected. In those crystals in which the band is best formed, it appears as a narrow black band even in bright light. When the band first appears as we recede from a normal incidence it is extremely narrow, but it rapidly increases in breadth as the angle of incidence is increased.

9. Some of the general features of the phenomenon were prettily shown in the following experiment:—

Choosing a crystal in which the bright band in the reflected light began to appear, as the incidence was increased, on the red side of the line D, so that on continuing to increase the incidence it passed through the place of the line D before it had become of any great width, I viewed through the crystal a sheet of white paper illuminated by a soda flame. A dark ring was seen on the paper, which was circular, or nearly so, and was interrupted in two places at opposite extremities of a diameter, namely, the places where the ring was cut by the plane of symmetry. The light of the refrangibility of D was so nearly excluded from the greater part of the ring that it appeared nearly black, though slightly bluish, as it was illuminated by the feeble radiation from the flame belonging to refrangibilities other than those of the immediate neighbourhood of D. The ends of the two halves of the ring became feeble as they approached the plane of symmetry. A subordinate comparatively faint ring lay in this crystal immediately outside the main one.

10. Suspecting that the production of colour was in some way connected with twinning, I examined the cleft edge of some of the crystals which happened to have been broken across, and found that the bright reflection given by the exposed surface was interrupted by a line, much finer than a hair, running parallel to the C faces, which could be easily seen with a watchmaker's lens, if not with the naked eye. This line was dark on the illuminated bright surface exposed by cleavage, a surface which I suppose illuminated by a source of light not too large, such as a lamp, or a window at some distance. The plane of incidence being supposed normal to the intersection of the cleavage plane by the C faces, on turning the crystal in a proper direction around a normal to the plane of incidence, the light ceased to be reflected from the cleavage surface, and after turning through a certain angle, the narrow line which previously had been dark was seen to glisten, indicating the existence of a reflecting surface, though it was much too narrow to get a reflected image from off it. The direction of rotation required to make the fine line glisten was what it ought to be on the supposition that the fine line was the cleavage face of an extremely narrow twin stratum.

11. On examining the fine line under the microscope, it was found to be of different thicknesses in different crystals, though in those crystals which showed colour it did not vary very greatly. On putting a little lycopodium on the cleavage face interrupted by the fine line, it was seen that in those crystals which showed colour the breadth of the twin stratum varied from a little greater to a little less than the breadth of a spore. The thickness

accordingly ranged somewhere about the thousandth of an inch, such being the diameter of the spores. The stratum was visibly thicker in those crystals which showed their bright band in the red than in those which showed it in the blue.

12. That the thin twin stratum was in fact the seat of the colour, admitted of being proved by a very simple experiment. It was sufficient to hold a needle, or the blade of a penknife (I will suppose the latter), close to or touching the surface of the crystal while it was illuminated by light coming approximately in one direction, suppose from a lamp, or from a window a little way off, and to examine the shadows with a watchmaker's lens. The light reflected from the crystal comes partly from the upper surface, partly from the twin stratum, partly from the under surface, which, however, may be too irregular to give a good reflection. The twin stratum is much too thin to allow of separating the light reflected from its two surfaces in an observation like the present, and it must therefore be spoken of as simply a reflecting surface. Corresponding to the three reflecting surfaces are three shadows, where the incident light is cut off: (1) from the upper surface, (2) from the twin stratum, (3) from the under surface. By examining these shadows in different crystals and under varied conditions, it is shown beyond doubt that the coloured reflection comes from the twin stratum.

The conclusion was confirmed by observations made with sunlight; but the simple method of shadows is quite as good, and even by itself perfectly satisfactory.

13. Another useful method of observation, not so very simple as the last, is the following. A slit, suppose horizontal, not very narrow, is placed in front of the flame of a lamp at some distance, and an image of the slit is formed by a suitable lens, such as the compound achromatic objective of an opera-glass. The crystal is placed so as to receive in focus the image of the slit, being inclined at a suitable angle, usually in a plane perpendicular to the plane of symmetry. The eye is held in a position to catch the reflected light, and the images formed by the different reflections are viewed through a watchmaker's lens. If the slit be not too broad, the images formed by reflection from the upper surface, from the twin stratum, and from the under surface are seen distinct from each other, so that the light reflected from the twin stratum may be studied apart from that reflected from the upper and under surfaces.

In this mode of observation it can readily be seen, by turning the crystal in its own plane, and noticing the middle image, which is that reflected from the twin stratum, how very small a rotation out of the position in which the plane of incidence had been the plane of symmetry suffices to re-introduce the coloured light, which had vanished in that critical position, which appears to be a position not merely of absence of colour, but of absence of light altogether; at least if there be any it is too feeble to be seen in this mode of observation, though from theoretical considerations we should conclude that there must be a very little reflected light, polarised perpendicularly to the plane of incidence.

14. On allowing a strong solution of chlorate of potash in hot water to crystallise rapidly, in which case excessively thin plates are formed in the bosom of the liquid, I noticed the play of colours by reflection mentioned by Professor Mills as belonging to the crystals in general at an early stage of their growth. This, however, proved to be quite a different and no doubt a much simpler phenomenon. The difference was shown by the polarisation of the light, and above all by the character of the spectrum of the light so reflected, which resembled ordinary spectra of interference, and did not present the remarkable character of the spectra of the peculiar crystals.

15. When, however, the whole was left to itself for a day or so, among the mass of usually colourless crystals a few were found here and there which showed brilliant colours. These colours were commonly far more brilliant than those of the crystals mentioned in the preceding paragraph, and they showed to perfection the distinctive character of the spectrum of the peculiar crystals. It would have been very troublesome, if possible at all, to examine the twinning of such thin and tender plates as those thus obtained by working on a small scale; but the character of the spectrum, which is perhaps the most remarkable feature of the phenomenon, as well as the dependence of the colour on the orientation, may be examined very well; and thus any one can study *these* features of the phenomenon, though he may not have access to such fine coloured crystals as those sent me by Professor Mills.

16. A certain amount of disturbance during the early stages of crystallisation, whether from natural currents of convection or from purposely stirring the solution, somewhat gently so as not to break the crystals, seems favourable to the production of the peculiar crystals. When the salt crystallised slowly from a quiet solution I did not obtain them.

17. As it is easy in this way, by picking out the peculiar crystals from several crystallisations, to obtain a good number of them, the observer may satisfy himself as to the most usual character of the spectrum. It is best studied at a moderate incidence, as it is sharper than when the incidence is considerable.

18. The number of coloured crystals obtained by crystallisations on a small scale, though very small, it is true, compared with the number of colourless ones, was still so much larger than Prof. Mills's description of the rarity of the crystals had led me to expect, that I at one time doubted whether the simply twinned crystals which are so very common, if taken at a period of their growth when one component is still very thin, and of suitable thickness, might not possibly show the phenomenon, though the thin twin was in contact on one face only with the brother twin, the other face being in the mother-liquor or in air. The circumstances of reflection and transmission at the first surface of the twin plate must be very different according as it is in contact with the brother crystal, or else with the mother-liquor, or air, or some other fluid; and yet the peculiar spectrum was shown all the same whether the crystal was in air, or immersed in the mother-liquor, or in rock oil. However, to make sure of the matter I took a simply twinned crystal, and ground it at a slight inclination to the C face till the twin plane was partly ground away, thus leaving a very slender twin wedge forming part of the compound crystal, and polished the ground surface. On examining the reflected light with a lens, no colour was seen about the edge of the wedge, where the thickness of the wedge tapered away to nothing; and that, although the bands seen near the edge in polarised light, which was subsequently analysed, showed that had colours been producible in this way, as they are by a thin twin stratum, they would not have been too narrow to escape observation.

In another experiment a simply twinned crystal was hollowed out till the twin plane was nearly reached. The hollowing was then continued with the wetted finger, so as to leave a concave smooth surface, the crystal being examined at short intervals in polarised light as the work went on, so as to know when the twin plane was pierced. But though in this case the twin plane formed a secant plane, nearly a tangent plane, to the worked surface, and near the section the twin portion of the crystal must have been very thin for a breadth by no means infinitesimal, as was shown by examination in polarised light, yet no colours were seen by reflection. I conclude therefore that the production of these colours requires the twin stratum to be in contact on *both* its faces with the brother crystal.

19. The fact that a single bright band is what most usually presents itself in the spectrum of the reflected light, though sometimes two or three such bands at regular intervals may be seen, seems to warrant us to regard that as the kind of spectrum belonging to the simplest form of twin stratum, namely, one in which there are just the two twin surfaces near together. The more complicated spectra seem to point to a compound interference, and to be referable to the existence of more than two twin planes very near together; and in fact in some of the crystals which showed the more complicated spectra, and which were broken across, I was able to make out under the microscope the existence of a system of more than two twin planes close together. Restricting ourselves to what may be regarded as the normal case, we have then to inquire in what way the existence of two twin planes near together can account for the peculiar character of the spectrum of the reflected or transmitted light.

Section II.—*Of the Proximate Cause of the Phenomenon.*—20. Though I am not at present prepared to give a complete explanation of the very curious phenomenon I have described, I have thought it advisable to bring the subject before the Society, that the attention of others may be directed to it.

That the seat of the coloration is in a thin twin stratum, admits I think of no doubt whatsoever. A single twin plane does not show anything of the kind.

For the production of the colour the stratum must be neither too thick nor too thin. Twin strata a good deal thicker than those that show colour are common enough; and among the crystals sent to me I have found some twin strata which were a good deal thinner, in which case the crystal showed no colour.

The more complicated spectra which are frequently observed seem referable to the existence of more than two twin planes in close proximity. There is no reason to think that the explanation of these spectra would involve any new principle not already contained in the explanation of the appearance presented when there are only two twin planes, though the necessary formulæ would doubtless be more complicated.

Corresponding to a wave incident in any direction, in one component of a twin, on the twin plane, there are in general two refracted waves in the second component in planes slightly inclined to each other, and two reflected waves which also have their planes slightly inclined to each other, the angle of inclination, however, being by no means *very* small, as chlorate of potash is strongly double refracting. The planes of polarisation of the two refracted waves are approximately perpendicular to each other, as are also those of the two reflected waves; but on account of the different orientation of the two components of the twin, the planes of polarisation of the two refracted waves are in general altogether different from those of the incident wave and of its fellow, the trace of which on the twin plane would travel with the same velocity. In the plane of symmetry at any incidence, and for a small angle of incidence at any azimuth of the plane of incidence, the directions of the planes of polarisation of the two refracted waves agree accurately or nearly with those of the incident wave and its fellow. In these cases, therefore, an incident wave would produce hardly more than one refracted wave, namely, that one which nearly agrees with the incident wave in direction of polarisation. In these cases the colours are not produced. It appears, therefore, that their production demands that the incident wave shall be very determinately divided into two refracted waves, accompanied of course by reflected waves

It seems evident that the thickness of the stratum affects the result through the difference of phase which it entails in the two refracted waves on arriving at the second twin plane. But whereas in the ordinary case of the production of colour by the interposition of a crystalline plate between a polariser and an analyser, we are concerned only with the difference of retardation of the differently polarised pencils which are transmitted across the plate, and not with the absolute retardation, it is possible that in this case we must take into account not only the difference of retardation for the differently polarised pencils which traverse the stratum, but also the absolute retardation; that is, the retardation of the light reflected from the second relatively to that reflected from the first twin plane.

21. I have not up to the present seen my way to going further. It is certainly very extraordinary and paradoxical that light should suffer total or all but total reflection at a transparent stratum of the very same substance, merely differing in orientation, in which the light had been travelling, and that, independently of its polarisation. It can have nothing to do with ordinary total internal reflection, since it is observed at quite moderate incidences, and *only within very narrow limits* of the angle of incidence.

RECENT PROGRESS IN CHEMISTRY[1]

THE progress of chemistry during the last year has been considerable, and a great deal of interesting and important work has been done. Nevertheless it cannot be said to have been a year productive of any very special discoveries. In physical chemistry the subjects connected with heat have occupied a good deal of attention, such as the heat of formation of chemical compounds, &c. Experiments on the liquefaction and solidification of gases by pressure and low temperature have also been continued, and, in addition to the results which were obtained some time since, we now know chlorine, not only as a liquid, but also as a crystalline solid. The same is true of hydrochloric acid, carbonic oxide, silicon fluoride, and assinuretted hydrogen.

Last year I referred to the work which was being done with hydroxylamine, and also mentioned that another analytical reagent of equal importance was claiming attention, viz. Emil Fischer's phenylhydrazine. The promise of new work which this substance gave has been fully realised, and it has proved useful, not only as an analytical reagent, but has been the means of producing a number of new and important products.

Work is still actively pursued on the pyrroline, pyridine, and quinoline series, and it is remarkable to see how new methods for the production of bodies of this description are being constantly discovered. Those of A. Behrmann and Hofmann, who obtain pyridine derivatives from citramide, and of H. v. Pechmann, who obtains them from malic acid, may be taken as illustrations.

It is interesting to notice, in reference to the pyridine series, Ladenburg's experiments (*Ber.*, xvii. 772-74), who finds that the compounds formed by the union of these bases with the iodides of the alcohol radicals, when strongly heated, yield substituted pyridines in the same way as Hofmann showed some time since that aniline, under like circumstances, yielded substituted anilines, such as toluidine, &c. Hofmann (*Ber.*, xvii. 1200) has also found that conine hydrochloride, when distilled with zinc dust, yields a base he has named conyrine, which he believes to be a propyl or isopropyl pyridine; and this, by treatment with hydriodic acid at 280°–300°, regenerates conine, which has exactly the same physiological action as the natural (though it is probably optically inactive). Ladenburg (*Ber.*, xvii. 1196) has obtained a propylpyridine which, when treated with sodium and alcohol, yields a base smelling very much like conine; it has many properties in common with conine, and, like it, is poisonous, acting in the same manner and to the same degree. It is, however, optically inactive, as might be expected. It will be remembered that Schiff (*Ann. Ch. Pharm.*, clvii. 352) obtained a base very similar to conine from isobutyric aldehyde and ammonia some years ago, but it did not appear to agree in all its properties with that body. From the new work which has been done in this subject we may now soon expect to have the constitution of this base definitely established. Ladenberg has also succeeded in producing piperidine from pyridine. The identity of this product with that obtained from piperine from pepper has been established (*Ber.*, xvii. 513-515).

Hofmann, while continuing his work on the action of bromine in alkaline solutions in amides, has found the curious fact that nitriles are produced in considerable quantities containing one atom of carbon less than the amide—in fact, corresponding with the amines formed in the reaction, and are, in all probability, produced from them by the removal of the hydrogen atoms. As these nitriles can be converted into amides by sulphuric acid, and again treated with bromine and alkali, it is evident that by this means we can gradually work down step by step from one member of the homologous series to another.

It will be remembered that Pechmann and Duisberg (*Ber.*, xvi. 2119-2128) succeeded in obtaining substituted coumarins and their hydroxy derivatives by acting on aceto and benzoylacetic acids with phenols. Pechmann (*Ber.*, xvii. 929-936) has now succeeded in obtaining coumarins by treating malic acid and phenols with sulphuric acid or chloride of zinc; with ordinary phenol he has obtained coumarin; with resorcinol, umbelliferone and with pyragallol, daphnetin, which gives all the reactions of the natural body.

Some very curious results have lately been obtained in reference to the destructive action of aluminium chloride on hydrocarbons. Friedel and Crafts communicated a paper on this subject to this Society in 1882; it has now been further studied by Auschütz, Immerdorff, and by Jacobson (*Ber.*, xviii. 657). They have found that this action consists in "a transference of the alcohol radical from one molecule of a hydrocarbon to another molecule of the same hydrocarbon." Thus toluene yields, on the one hand, benzene, and on the other, xylene and more highly methylated benzenes, orthoderivatives being very rarely found among the products.

Last year I referred to the discovery of thiophene, or, more properly, thiophen, and its homologues by Victor Meyer. During the year our knowledge of this interesting body has been considerably extended, and its preparation rendered comparatively easy. H. E. Schulze (*Ber.*, xviii. 497) has recently shown that it is contained—as might be expected—in the sulphuric acid used to purify crude benzene, and that if its decomposition be prevented by diluting the acid with an equal bulk of water as soon as it is separated from the benzene, the thiophen which is doubtless present in the form of a sulpho acid may easily be recovered by hydrolysing, by merely passing steam into the acid liquid.

The synthesis of thiophen, recently effected by J. Volhard and H. Erdmann (*Ber.*, xviii. 454) by merely distilling sodium succinate with phosphorus trisulphide (by which about 50 per cent. of the theoretical yield is obtained), is also of interest, as well as the production of methylthiophen from sodium pyro-

[1] From the Annual Address of the President of the Chemical Society, Mr. W. H. Perkin, F.R.S., March 30, 1885.

tartrate by the same reagent. The methylthiophen, however, appears to be isomeric with that separated from coal-tar toluene by Victor Meyer. According to Volhard and Erdmann, thiophen, when cooled in a mixture of carbon dioxide and ether, crystallises like benzene. Paal's synthesis of methyl-phenyl-thiophen from aceto-phenone-acetone, and of thiophen-carboxylic acid—which is easily resolved into carbon dioxide and thiophen—from mucic acid, may also be referred to here.

One of the most interesting of recent researches is that of R. Nietzki and T. Benckser on hexhydroxybenzene $(C_6HO)_6$ (*Ber.*, xvii. 499)), which they have succeeded in obtaining from nitranilic (dinitrodehydroxyquinone). They find the diimido body obtained from this when treated with nitric acid, yields a product of the composition $C_6H_{16}O_{14}$, which when treated with reducing agents, yields this substance. They also find that when heated with concentrated nitric acid, hexhydroxybenzene is converted into a body having the remarkable formula $C_6H_{16}O_{14}$. This decomposes when heated to 100°, or when boiled with water, carbon dioxide being given off, and on adding potash solution to the residue or the boiled solution, orange yellow needles of a potassium salt of the formula $C_5K_2O_5$ are obtained, which they have identified as potassium croconate, and they believe that the bodies obtained by Lerch (*Am. Chem. Pharm.*, cxxiv. 20) from the compounds of potassium carbonic oxide (formed during the preparation of the metal) were hexyhydroxybenzene, tetrahydroxyquinone, and the compound $C_6H_{16}O_{14}$, and in fact that the compound $C_6(OK)_6$ is present in "potassium carbonic oxide." From experiments on the remarkable substance $C_6H_{16}O_{14}$, they came to the conclusion that it is a compound of $C_6O_6 + 8H_2O$, and is a quinone which they call triquinoylbenzene. This appears to be confirmed by the production of the intermediate hydroxy compounds, the following being the series of products ;—

$$C_6(OH)_6,$$
$$C_6(OH)_4O_2,$$
$$C_6(OH)_2O_4,$$
$$C_6O_6.$$

In reference to agricultural chemistry Messrs. Lawes and Gilbert have contributed a most important and interesting paper to our Society (1884, pp. 305-407) on the ash of wheat-grain and wheat-straw. They gave the analyses of no less than ninety-two wheat-grain and wheat-straw ashes, every ash being of produce of known history of growth as to soil, season, and manuring, all the specimens having been grown at Rothampstead. Out of the many important deductions this paper contains, the following are extremely interesting :—It appears, in reference to the grain, that on the whole there is great uniformity in its mineral composition under different conditions of manuring, provided only it is perfectly and normally ripened. The influence of season producing a much wider range in the mineral constituents of the grain than the manuring. This, however, is not the case with the straw, as it is found that the amount of mineral ash constituents found in the straw, and therefore in the total crop, have a very direct connection with the amounts available in the soil, but the amounts stored up in the grain itself are little influenced by the quantity taken up.

Besides the researches just referred to there has been a considerable amount of good work done, but it would be out of place for me to refer to it more fully in this short review.

Last year I took occasion to refer to the comparatively small amount of original work which was being prosecuted in this country, notwithstanding the increased number of laboratories and the greater facilities which existed for the encouragement of research. It will be seen from the list of papers that the number brought before the Society during the past year has not increased, but if the papers themselves are examined I think we shall find that the amount of work done is somewhat larger, though certainly not so large as it should be ; and it is to be hoped that the spirit of research will be stimulated in the laboratories of the kingdom, and that men may be turned out who are not only more or less analysts, but thorough chemists. Let us not be contented with looking back with pride to what our ancestors have done, but let us follow their example.

SCIENTIFIC SERIALS

Annalen der Physik und Chemie, January 15, No. 2, 1885.—Determination of Verdet's constants in absolute units (2 figures), by Prof. Leo Arons.—On the formation of ozone hydrogen peroxide and peroxide of sulphur (S_2O_7) by the electrolysis of dilute sulphuric acid (2 figures), by Franz Richarz.—Reply to some statements by F. Kohlrausch, by H. Wild.—On the method of damping for determining the ohm, by Lord Rayleigh.—On the determination of specific heats and melting points at high temperatures (11 figures and 6 tables).—Inaugural address, by Otto Ehrhardt.—Two new methods of finding the angle of polarization of metals, by H. Knoblanch (tables).—The determination of the specific heat of uranium, by Ad. Blüncke.—Experimental research on laws of the emission of light from glowing bodies (5 figures and 7 tables), by W. Möller.—Remarks on J. Fröhlich's treatise, "Kritisches zur Theorie des gebeugten Lichts," by M. Réthy.—Observations on fluorescence, by E. Lommel.—On the double acetates of uranium (9 figures), by C. Rammelsberg.—Note on Kundt's dust figures (2 figures), by H. J. Oosting.

Journal de Physique Théorique et Appliquée, February.—Observations upon the corona now visible around the sun, by M. A. Cornu.—Researches on the combustion of gaseous explosive mixtures, with figures and tables, by MM. Mallard and Le Chatelier.—A new telegraphic system, by M. Estienne.—An experiment in hydrodynamics, by M. P. Parize.—A magneto-electric phenomenon, by C. V. Boys.—A new interference phenomenon produced by sheets of glass with parallel surfaces, and on a method of verifying the parallelism of the surfaces of these sheets, by O. Lummer.—Influence of change of condition from the liquid to the solid state on vapour-pressure, by W. Ramsay and Sydney Young.—Non-sparking key, by W. E. Ayrton and John Perry.—A new arrangement for measuring work, by C. F. Brackett.—Coloured dust particles, by H. H. Hagen.—The horizontal motion of small floating bodies, and the truth of the postulates of the theory of capillarity, by J. Leconte.—Method of registering the free vibrations of a tuning-fork, and the beats, by A. G. Compton.—The expression of electrical resistance as the function of velocity, by F. E. Nipher.—Contributions to meteorology : the reduction of barometric observations to the sea-level, by E. Loomis.—The influence of light on the electrical resistance of metals, by A. E. Bostwick.—On atmospheric absorption, by S. P. Langley.—On the absorption of radiant heat by carbonic acid gas, by J. E. Veller.—The duration of luminous impressions on the retina, by E. L. Nichols.—The relation between the electromotive force of a Daniel cell and the strength of the solutton of zinc sulphate, by H. S. Cattzart.

The Journal of the Franklin Institute, No. 710, February, 1885.—Electro-metallurgy, by Nathaniel S. Keith. A lecture delivered at the International Electrical Exhibition of the Franklin Institute, Tuesday, September 23, 1884.—The divining rod, by Rossiter W. Raymond, Ph.D. Conclusion of a lecture delivered at the International Electrical Exhibition, September 18, 1884.—Glimpses of the International Electrical Exhibition, by Prof. Edwin J. Houston. No. 5, Edison's telephonic inventions. Annual summary of engineering and industrial progress, 1884.—Report of the Franklin Institute ; items ; Japanese colony in Germany ; spontaneous decomposition of explosive gelatine ; a new refractory brick ; globular lightning ; solar phenomena in Switzerland ; supplement ; International Electrical Exhibition report on underground wires. The following systems are described : the American Sectional Underground Company ; the Anderson conduit for underground wires ; the Brook's underground conduit ; the Continental Underground Cable Company ; the Cosmopolitan Underground Telegraph, Telephone, and Electric Light Company of New Jersey ; the Electric Tube Company ; the National Underground Company of New Jersey ; Henley's conduit for underground lines ; Magner's underground conduit ; Philadelphia and Seaboard Telegraph and Cable Company (Pennock's) ; the Union Electric Underground Company of Chicago ; Woodward's curb conduit ; the Delany Cable.

Rivista Scientifico-Industriale, February 15-28.—Description of a new galvanometer, with illustration, by Aurelio Mauri.—Experimental researches on earth-currents and those of absorption, by Prof. Antonio Racchetti.—Variations in the electric resistance of solid and pure metallic wires, according to the temperature (continued), by Prof. Angelo Emo.—On an improved method of preserving butterflies' wings, by P. Milani and A. Garbini.

Rendiconti del R. Istituto Lombardo, February 26.—Report on soundings taken in lakes Orta and Idro, Lombardy, for the purpose of determining their mean depths, by Prof. Pietro Pavesi.

—On the analogy observed by Warming between Koch's comma bacillus and *Spirillum tenue*, Ehr., by Prof. Leopold Maggi.—On an integer more general than that of living forces, for the movement of a system of material points, by Dr. Giovanni Pennacchietti.—On the psychological action of *attention* in the animal series (continued), by E. T. Vignoli.—On Grimaldi's proposed agrarian credit to relieve the distress of the Italian peasantry, by P. Manfredi.—Remarks on the *legatum optionis* of Roman jurisprudence, by Prof. C. Ferrini.—Critical inquiry into the new Italian Penal Code, by Prof. A. Buccellati.—Meteorological observations made at the Brera Observatory, Milan, during the month of February.

SOCIETIES AND ACADEMIES

London

Royal Society, March 19.—"The Paralytic Secretion of Saliva." By J. N. Langley, M.A., F.R.S.

It has been shown by Claude Bernard and by Heidenhain that section of the chorda tympani nerve on one side, causes a slow continuous secretion from both sub-maxillary glands. Since the secretion which takes place on the side of the body on which the nerve is cut is called the "paralytic" secretion, that which takes place on the opposite side may be called the "anti-paralytic" or "antilytic" secretion. The author finds that the antilytic secretion becomes slower when the chorda tympani nerve is cut, and stops when, in addition, the sympathetic nerve is cut. It is, then, caused by nervous impulses sent out by a secretory centre in the medulla oblongata. This centre is in a state of increased irritability, for dyspnœa causes a much more rapid flow of saliva, and causes it sooner than it does normally. The paralytic secretion during the first day or two of its occurrence is also caused by stimuli proceeding from the central secretory centre; since the paralytic secretion is more copious than the antilytic secretion, and since dyspnœa causes a greater increase of the former than of the latter, it follows that the increase of irritability in the central secretory centre is greater on the side on which the chorda tympani has been cut than on the opposite side. In this state of increased irritability the central nerve-cells are probably stimulated by the blood supplied to them. The paralytic secretion in its later stages is probably brought about by a similar state of increased irritability in nerve-cells in the gland itself, *i.e.* of a local secretory centre. In its later stages the secretion continues after severance of all the nerve-fibres proceeding from the central nervous system to the gland; it is, however, increased by dyspnœa, stopped by apnœa, and by large doses of anæsthetics, which indicates that it is brought about by nerve-impulses. The peripheral end of the chorda tympani remains irritable for two to three weeks, which is a further indication that the secretory nerve-fibres are connected with some, at any rate, of the many nerve-cells present in the gland. Notwithstanding the continuous paralytic secretion, the gland-cells become slightly more mucous than normal; except for this and a decrease in size they remain normal. They secrete as usual when the sympathetic nerve is stimulated.

Geological Society, March 25.—Prof. T. G. Bonney, D.Sc., LL.D., F.R.S., President, in the chair.—Charles De Laune Faunce De Laune and William Hill were elected Fellows of the Society.—The following communications were read:—On the relationship of *Ulodendron*, Lindley and Hutton, to *Lepidodendron*, Sternberg, *Bothrodendron*, Lindley and Hutton, *Sigillaria*, Brongniart, and *Rhytidodendron*, Boulay, by Robert Kidston, F.G.S.—On an almost perfect skeleton of *Rhytina gigas = Rhytina Stelleri* ("Steller's sea-cow") obtained by Mr. Robert Damon, F.G.S., from the Pleistocene peat-deposits on Behring's Island, by Henry Woodward, LL.D., F.R.S., F.G.S. The author spoke of the interest which palæontologists must always attach to such animals as are either just exterminated or are now in course of rapid extirpation by man or other agents. He referred to the now rapid destruction of all the larger Mammalia, and expressed his opinion that the African elephant, the giraffe, the bison, and many others, will soon be extirpated unless protected from being hunted to death. The same applies to the whale- and seal-fisheries. He drew attention to a very remarkable order of aquatic animals, the *Sirenia*, formerly classed with the Cetacea by some, with the walruses and seals by others, and by De Blainville with the elephants. He particularly drew attention to the largest of the group, the *Rhytina*, which was seen alive and described by Steller in 1741. It was then confined to two islands (Behring's Island and Copper Island). In forty years (1780) it was believed to have been entirely extirpated. It was a toothless Herbivore, living along the shore in shallow water, and was easily taken, being without fear of man. Its flesh was good, and it weighed often three or four tons. The author then described some of the leading points in the anatomy of *Rhytina*, and indicated some of the characters by which the order is distinguished. He referred to the present wide distribution of the Sirenia:—*Manatus* with three species, namely, *M. latirostris*, occupying the shores of Florida and the West Indies; *M. americanus*, the coasts of Brazil and the great rivers Amazon and Orinoco; *M. senegalensis*, the west coast of Africa and the rivers Senegal, Congo, &c. *Halicore*, with three species, namely, *H. tabernaculi*, the Red Sea and east coast of Africa; *H. dugong*, Bay of Bengal and East Indies; *H. australis*, North and East Australia. The fossil forms number thirteen genera and twenty-nine species, all limited to England, Holland, Belgium, France, Germany, Austria, Italy, Malta, and Egypt, and to the United States and Jamaica. The author gave some details as to the dentition of fossil species, of which *Halitherium* and *Prorastomus* are the two most remarkable types. Lastly, with regard to the geographical area occupied at the present day by the Sirenia, the author pointed out that two lines drawn 30° N. and 30° S. of the equator will embrace all the species now found living. Another line drawn at 60° N. will show between 30° and 60° N. the area once occupied by the twenty-nine fossil species. He looked upon *Rhytina* as a *last surviving* species of the old Tertiary group of Sirenians, and its position as marking an "*outlier*" of the group now swept away.

Physical Society, March 28.—Prof. Guthrie, President, in the chair.—The President announced that the meeting on May 9 would be held at Bristol; further particulars would be communicated to the members.—Mr. Hawes was elected a member of the Society.—The following papers were read:—On calculating-machines, by Mr. Joseph Edmondson. Calculating-machines are of two classes—the automatic and the semi-automatic. The former were invented by Mr. Charles Babbage between 1820 and 1834, and were designed mainly for the computation of tables. The difficulties against which this inventor contended and the perseverance he displayed in the construction of part of the "difference-engine" he had imagined are now a matter of history. On account of the great cost and high degree of complexity of this machine it was never completed, and the calculating-machines of the present day belong to the semi-automatic class the first example of which is found in a rough and incomplete instrument by Sir Samuel Moreland in 1663. From 1775 to 1780 the Earl of Stanhope invented machines which were a great advance upon those of Sir S. Moreland. In these is found the "stepped reckoner," the basis of all modern instruments. This "stepped reckoner" was improved by M. Thomas de Colmar, who, in 1851 produced a machine which is now largely in use. This machine, somewhat improved in detail and construction, is now made by Mr. Tate of London, and Mr. Edmondson has patented a modification in which the form of the instrument is circular, by which means an endless instead of a limited slide is obtained. A collection of various valuable instruments, which had been kindly lent for the occasion, were exhibited. A discussion followed in which Gen. Babbage, Mr. Tate, Prof. McLeod, Dr. Stone, the Rev. Prof. Harley, Mr. Whipple, Prof. Ayrton, and other gentlemen took part.—On the structure of mechanical models illustrating some properties in the ether, by Prof. G. F. Fitzgerald. The author had recently constructed and described before the Royal Society of Dublin a model illustrating certain properties of the ether (NATURE, March 26, p. 498). This model was one-dimensional, but the author now showed how a tri-dimensional model might be imagined, though probably mechanical difficulties would render its actual construction impossible. Each element of the ether is to be represented by a cube on each edge of which there is a paddle-wheel. Thus on any face of the cube there will be four paddle-wheels. Now, if any opposite pair of these rotate by different amounts, they will tend to pump any liquid in which the whole is immersed into or out of the cube, and if the sides of the cube be elastic there will be a stress which will tend to stop this differential rotation of the wheels. If however the other pair rotate by different amounts, they may undo what the first pair do, and thus the stress will depend on the difference between the differential rotations of these opposite pairs of wheels. If η represent the angular rotation of one pair, and ζ that of the

other, the stress will depend upon $\frac{d\eta}{dx} - \frac{d\zeta}{dy}$. In order that these four wheels may not similarly work with any other wheel, it is necessary to place diaphragms dividing the cube into six cells, each a pyramid standing on a face of the cube. They must be so made that liquid may not be able to pass from one cell to another through the diaphragm or beside the paddle-wheels; to effect this the floats on the paddle-wheels would have to be drawn down while passing the diaphragms. Thus the energy of distorsion of such a medium would depend upon

$$\left(\frac{d\zeta}{dy} - \frac{d\eta}{dz}\right)^2 + \left(\frac{d\xi}{dz} - \frac{d\zeta}{dx}\right)^2 + \left(\frac{d\eta}{dx} - \frac{d\xi}{dy}\right)^2.$$

And Maxwell has shown that this is also true for the ether. The faces of the cubes should be filled up with diaphragms, past which the paddles should pump liquid, and whose elasticity should be the means of storing electrostatic energy in the medium. The most complicated results follow from supposing the faces of the cubes of which the medium is constructed to have different elasticities. Such a structure represents a crystalline medium, and vibrations would be propagated in it according to laws the same as those regulating the transmission of light in crystalline media. If the cubes were twisted, the structure would be like that of quartz or other substances rotating the plane of polarisation. To represent magnetic rotation of the plane of polarisation it would be necessary to introduce some mechanism connecting the ether with matter. The author, in conclusion, insisted upon a view which regards the vibrations constituting light to be of the nature of alterations of structure, and not of displacements executed in a medium possessing the properties of an elastic jelly.—At the close of the meeting the following instruments were exhibited and described in a conversational manner by their makers: a chrono-barometer and a chrono-thermometer by Mr. Stanley. These instruments consisted of clocks regulated by pendulums formed in the first instrument of a mercurial barometer, and in the second of a similar barometer inclosed in a hermetically-sealed air-chamber, the inclosed barometer thus acting as an air-thermometer. Increase of pressure in the one case, and of temperature in the other, causes the mercury to rise, and thus accelerates the pendulum. By the gain or loss of time the mean pressure or temperature can be calculated for any period.—A heliostat and a galvanometer, by Mr. Conrad W. Cooke. The galvanometer is intended to show the internal current in a cell. The battery plates are in two cells connected by four glass tubes in multiple arc coiled around an astatic needle. The glass work is by Mr. Gimingham.—A spherometer, by Mr. Hilger, was made of aluminium, and combined lightness with rigidity. By an electrical contact the maker asserted that measurements could be made to one-millionth part of an inch.—Col. Malcolm exhibited a spectroscope and a binocular field-glass in which the two eyepieces were separately adjustable; and Dr. Watts exhibited a simple modification of a quadrant electrometer.

Royal Microscopical Society, March 11.—Rev. Dr. Dallinger, F.R.S., President, in the chair.—Mr. Crisp exhibited Winkel's class microscope with movable stage, Tolle's clinical microscope, Seibert's portable microscope, and Swift's microscope for examination of skin of sheep having a very long working distance, Griffiths' and Bertrand's objective adapters and a new form of "finder."—Mr. H. G. Madan exhibited some new kinds of glass, having found that a combination of ordinary blue glass with a peculiar bluish-green glass, known as "signal-green" glass, was much more convenient than the usual glass cell filled with solution of cuprammonium sulphate.—Mr. Baker exhibited some object-boxes in book-form for placing on a shelf with books, the objects then lying flat.—Dr. C. v. Zenger's letter was read describing a new mounting medium consisting of tribromide of arsenic in bisulphide of carbon, and giving a refractive index of from 1·6696 to 1·7082. An improved slide for viewing the object on both sides was also described.—Mr. C. H. Hughes's description was read of a stage for use with high powers to prevent the decentring of the condenser, especially when used with immersion contact. Vertical, horizontal, and oblique motions are given to the slide, while the stage remains stationary but can be rotated.—Mr. E. M. Nelson exhibited a drawing of comma bacillus showing the flagella.—Mr. J. Mayall, jun., described the original ruling machine of the late Herr F. A. Nobert, which was exhibited to the meeting. The foundation of the machine was a dividing engine calculated to produce parallel divisions far finer than could be marked by any ruling point yet discovered. The division-plate had twenty circles of "dots," and these were supplemented by extremely fine graduations on two bands of silver imbedded near the edge, which were viewed by means of two compound microscopes, each provided with eyepiece screw micrometers of special construction. The movement of rotation was effected by a fine tangent screw acting on a worm on the vertical edge of the division-plate. The method employed by Herr Nobert for obtaining the minute divisions of his test-plates (ranging from 1-1000th to 1-20,000th of a Paris line) was to convert the radius of the division-plate into a lever to move the glass plate on which the rulings were made at right angles to the motion of the ruling point. For this purpose he attached to the centre of the rotating division-plate a bent arm, on which slid a bar of silver, having at one end a finely-polished steel point which could be adjusted by a scale and vernier so as to project more or less beyond the centre of the division-plate or axis of rotation. The radius of the division-plate thus became the long arm of the lever, whilst the radius of the projection of the polished steel point beyond the axis of rotation formed the short arm, the centre of the division-plate being the fulcrum. The motion of the short arm of the lever was communicated by contact with an agate plate to a polished steel cylinder adjusted to slide at right angles to the movement of the ruling point in V-shaped bearings of agate. The steel cylinder carried a circular metal table, on which the glass plate to be ruled was fixed by wax and clamps. The arrangement for carrying the diamond point was, he believed, wholly designed by Herr Nobert, and was a most ingenious combination of mechanism.—Mr. Mayall referred briefly to the preparation of the glass plates for the rulings, which, he said, were of specially "mild" composition. It was abundantly proved by Herr Nobert's work that the perfection of the mechanical part of the dividing-engine was not the only difficulty which he had understood, and conquered. There was a still greater dfficulty which he had understood, and in which he had met with a success that gave him pre-eminence in this department of micro-physics, and that was the preparation of the diamond ruling-points. The description of these was deferred until the next meeting.—Mr. C. Beck exhibited a modification of the "complete" lamp fitted with a shallow glass reservoir instead of the original one of metal, also a vertical illuminator with a new form of diaphragm.—Dr. Van Heurck's note was received, sending a copy of Prof. Abbe's opinion on the photographs of the "beads" of *A. pellucida*, in which he stated that he had no reason to doubt the reality of the beads.—Dr. J. D. Cox's note was read as to actinic and visual foci.—Mr. F. Kitton's remarks in commendation of balsam of Tolu for mounting were read.—Dr. Ord exhibited and described some objects illustrating the erosion of the surface of glass when exposed to the action of carbonate of lime and a colloid.—Mr. J. W. Stephenson read his paper, on a new catodioptric illuminator, having an aperture exceeding that of any existing objective, or equal to 1·644 N.A. in flint glass, and 1·512 N.A. in crown glass.—Mr. Cheshire and Mr. E. Chayne's paper on the pathogenic history of a new bacillus (*B. alvei*) was then read, in which it was shown that the disease attacking bees, and known as "foul brood," was due to a bacillus. They had also discovered that the disease yielded readily to treatment which consisted in feeding the larvæ with a syrup containing 1-600 per cent. of phenol. A detailed explanation was given of the methods adopted in tracing out the life-history of the bacillus, and a series of tubes and bottles in which its propagation had been carried on were exhibited.—Mr. Fowke read a paper on the first discovery of the comma bacillus of cholera. He showed that the bacillus was known and recognised thirty-five years ago by two Englishmen, Messrs. Brittain and Swayne. It was pointed out that it was by the breaking up of the rings discovered by original observers that the so-called "comma" bacilli were formed.—Sixteen new Fellows were proposed and elected.

MANCHESTER

Literary and Philosophical Society, February 10.—Prof. W. C. Williamson, LL.D., F.R.S., President, in the chair.—On some undescribed tracks of invertebrate animals from the Carboniferous rocks, and on some inorganic phenomena, simulating plant remains, produced on tidal shores, by Prof. W. C. Williamson, LL.D., F.R.S., President. Prof. Williamson's memoir first contained descriptions and figures of a new form of Chrossocorda, which he named *C. tuberculata*, from the Yoredale rocks of Stonyhurst, in Lancashire, which genus has hitherto been found only in Palæozoic rocks of much older age than the Yoredale beds. Reciting the views of Schimper and

others, who believe that the genus Chrossochorda represents some fucoidal form of Palæozoic life, the author regards the various modifications of it as consisting of tracks of marine animals, probably crustaceans. He assigns the name of *Chrossochorda tuberculata* to that now described. A second form of track, of a different type, was found by Mr. J. W. Davis, F.G.S., of Chevinedge, near Halifax. It consists of a line of curved footprints in groups of eight—four on each side—the successive groups varying from five-eighths of an inch to two inches apart from each other. The specimen described was found in a quarry of Yoredale beds, near Hawes. The author assigns to it the name of *Protichnites Davisi*, after its discoverer. Casts of two series of markings, produced by water, were exhibited and described. One of these series represented branching forms easily mistaken for fucoidal remains. They were in reality casts, made in plaster of Paris, of remarkable drainage lines left by the retiring tide, on the sandbanks at Llanfairfechan, in North Wales. The second series consisted of allied objects, but in this case drainage lines had combined with ripple marks to produce an effect easily mistaken for the geometrically arranged scale-leaves of some cycadean stem. These casts were obtained from sandbanks to the north of Barmouth. The author called attention to the controversy bearing on these subjects still in progress, especially between Prof. Nathorst and the Marquis of Saporta, and renewed an objection, recorded in more than one of his previous publications, to such anomalous objects as those in dispute being made use of, when attempting to frame, from Palæontological evidences, a pedigree of the vegetable world.

CAMBRIDGE

Philosophical Society, March 16.—Prof. Foster, President, in the chair.—The following communications were made :—Further remarks on the urea-ferment, by Mr. Lea.—On some points in the anatomy of Nebalia, by Mr. Weldon.—Observations on the constitution of callus, by Mr. Walter Gardiner.—Observations on vegetable proteids, by Mr. J. R. Green.—On the development of K', E', J', G' in powers of the modulus (Part II.), by Mr. J. W. L. Glaisher.

SYDNEY

Linnean Society of New South Wales, January 28.—Annual General Meeting.—The President, C. S. Wilkinson, F.L.S., in the chair.—The President delivered an address upon the Pleistocene period, and its influences upon the present distribution of the fauna and flora of Australia. He gave also a short review of the work of the Society during the past year.—It was resolved that ladies may be admitted upon election as associates of the Society, with all the privileges of ordinary members except the right to attend the monthly meetings, at the reduced subscription of one guinea, without entrance fee.—The following papers were read :—A monograph of the Australian sponges : Part iv., the Myxospongiæ, by R. von Lendenfeld, Ph.D. In this paper the Australian species are described. (The author partly adopts the view of Sollas regarding the separation of the Halisarcidæ and Gumminæ.) The structure of Bajalus, a new genus of Halisarcidæ, is described. The subdermal cavities are remarkably developed. Amœboid wandering cells were found in a dense layer beneath the outer skin. Gland cells are described. Sexual products mature only in the innermost part. The gastral cavity serves as a marsupium. The anatomy of *Chondrosia Ramsayi*, n.sp., *Chondrilla papillata*, n.sp., and *corticata*, n.sp., shows some points of interest. Peculiar subdermal cavities are described in the former. The two latter possess a special cortical skeleton.—The method of section-cutting with some improvements, by R. von Lendenfeld, Ph.D.—*Amœba parasitica*, a new parasitic Protozoan infesting sheep, by R. von Lendenfeld, Ph.D.—The meteorology of Mount Kosciusko, by R. von Lendenfeld, Ph.D.—The Glacial period in Australia, by R. von Lendenfeld, Ph.D. The author gives the results of his recent expedition to the central part of the Australian Alps in this paper, as far as they bear on the above question. He ascended the two highest peaks in Australia, and found on the plateau which surrounds them undoubted glacial remains in the shape of *roches moutonnées* in many places above 5800 feet. He concludes that Australia was affected by a glacial period at the same epoch as New Zealand, but that, owing to the lowness of the mountains (only 7256 feet the highest peak), the low latitude, and the warm and dry winds from the interior, the glaciers attained but small dimensions, and only covered an area of about 100 square miles. He considers it probable that no other glaciers existed in Australia at the time, as even those on the highest elevation of the continent were so small.—On the Proteaceæ, by the Rev. W. Woolls, Ph.D., F.L.S.—On a new snake from the Barrier Ranges, by William Macleay, F.L.S., &c. The description is here given of a species of *Furina*, to which the specific name of *Ram ayi* is affixed. Some specimens of it were exhibited, as well as specimens of *Vermicella*, *Typhlops*, and *Delma*, from the same locality.

PARIS

Academy of Sciences, April 6.—M. Boulay, President, in the chair.—Obituary notice of M. Rolland. Member of the Section for Mechanics, who died on March 31, by the President.—Remarks on the agreement between geological and cosmogonic epochs, by M. Faye. These remarks are made in connection with his work, "Sur l'Origine du Monde," recently presented to the Academy, in which he develops his theory on the cosmic evolution of the solar system. Here this theory is supported by fresh arguments drawn from thermodynamics, biology, and solar physics.—On the artificial and supplementary manures proper for soil of different qualities, by M. de Gasparin. It is shown by numerous examples that such manures should be selected, not only according to the nature of the crops to be raised, but also according to the character of the lands requiring to be enriched.—On the resistance offered by a fluid in repose and without weight to the varied movement of a solid sphere immersed in it when the velocities are continuous, but so slow that their squares and products may be neglected, by M. J. Boussinesq.—On the "polhodie," a curve introduced by Poinsot into his new theory on the rotation of bodies, by M. A. Mannheim.—On the liquefaction and solidification of formene and of the deutoxide of nitrogen, by M. K. Olszewski.—On the amides of the oxalo-adipose group, by M. L. Henry.—Funeral orations pronounced at the obsequies of M. Rolland on April 7, by MM. Phillips and Schlösing.

STOCKHOLM

Royal Academy of Sciences, March 11.—Prof. Gylden communicated a paper by A. Shdanow on the computation of the intermediate orbit of the comet of Faye-Möller when it was in the vicinity of Jupiter in 1841.—Prof. Mittag-Leffler presented papers (1) on periodical functions with a discontinuous period-system of the first kind, by himself; and (2) annotations on the mathematician, Petrus de Dacia, and his writings, by G. Engström.—The Secretary, Prof. Lindhagen, presented (1) the doctrine of Linnæus on the species of plants determined and permanent in the nature, represented according to the works of Linnæus and compared with the corresponding views of Darwin, by Prof. T. G. Agardh ; (2) Desmidiæ collected during the expedition of Nordenskiöld to Greenland in 1870, by Prof. Berggren, and described by Dr. O. Nordstedt.

CONTENTS

THURSDAY, APRIL 23, 1885

THE "CHALLENGER" EXPEDITION

Report on the Stalked Crinoidea Collected during the "Challenger" Expedition. By P. Herbert Carpenter, M.A., D.Sc. 4to, pp. 440, with 69 Plates. (London: Printed for Her Majesty's Stationery Office.)

"THE Stalked Crinoids," says Mr. Murray in his prefatory notice to this Report, "both on account of their rarity and their palæontological relations, are perhaps the most interesting and remarkable of deep-sea animals, and have been in a special manner associated with the *Challenger* Expedition. The joint work of the late Sir C. Wyville Thomson and Dr. W. B. Carpenter, first on *Comatula* and afterwards on *Pentacrinus*, together with the discovery by Prof. G. O. Sars of *Rhizocrinus* off the Lofoten Islands in 1864, led directly to the expeditions of the *Lightning* and the *Porcupine* in 1868 and the following years; and was thus indirectly concerned in the despatch of the *Challenger* Expedition in 1872." Not only for these reasons, but also on account of the exceptional value of Dr. P. H. Carpenter's Report, we shall give it a full notice.

Every scientific Palæontologist regards the group of *Crinoidea* with special interest. Not only do its fossilized skeletons present themselves—frequently in a state of admirable preservation—in almost all marine limestones from the Lower Silurian to the present time; but they are not unfrequently found to furnish by their accumulation no inconsiderable proportion of the calcareous material of such formations. And in the course of this long succession they exhibit a number of remarkable changes of type, each characteristic of a particular epoch. The most singular errors formerly prevailed respecting their zoological relations; and it was not until the publication in 1821 of the "Natural History of the *Crinoidea*," by J. S. Miller, a German naturalist residing in Bristol, that any successful attempt was made to systematise the group, by showing the true relation of its diversified forms to each other and to existing types. Miller was acute enough to recognise the close resemblance in the skeleton of the Liassic Crinoids first differentiated by him as *Pentacrini*—not only to that of a stalked Crinoid still living in the West Indian seas (which he described under the name of *Pentacrinus caput Medusæ*), but also to the unstalked *Comatula* of our own shores, which had been previously ranked with *Euryale* as an Ophiurid; and taking this as his point of departure, he worked out the morphology of the other fossil Crinoids then known, with a success which has rendered his Monograph the foundation of all that has been since done for the systematic arrangement of the multitudinous extinct forms which palæontological research is continually bringing to light. His recognition of the Crinoidal character of *Comatula* was afterwards fully confirmed by the discovery, made in 1836 by Mr. J. V. Thompson of Cork, that *Comatula* passes the earlier part of its life in the attached condition as a Pentacrinoid; dropping off its stem at a certain stage of its growth, and thenceforth remaining free.

The "epoch-making" monograph of J. S. Miller was followed in 1834 by the now classical Memoir of Joh. Muller, of Berlin, "Ueber den Bau des *Pentacrinus-caput Medusæ*"; of which recent type the soft parts were then for the first time described. The material for this description was chiefly furnished by a single spirit-specimen of the West Indian *Pentacrinus;* but as this wanted its visceral mass, the description of that part was supplied from *Comatula*, the structure of whose arms and ventral disk was found to conform very closely to that of the same parts in *Pentacrinus*. Müller completely reformed the nomenclature of his predecessor; and his designations of the several pieces of the Crinoid skeleton are now adopted by all writers on the group. And as, in addition, he was the first to give an account (although in several respects an erroneous one) of the nutritive and reproductive apparatus of the Crinoids, his memoir constitutes, as it were, the basement-story of the edifice whose foundation had been laid by J. S. Miller.

This was afterwards further built upon by Prof. Wyville Thomson and Dr. W. B. Carpenter; who, seeing that a thorough study of the entire life-history of *Comatula* would be likely to furnish a key to that of the extinct Crinoids, agreed to prosecute it conjointly: the former undertaking the earliest stage, that of the free-swimming pro-embryo (whose existence had been made known by Busch, a pupil of Müller), up to the time of its first attachment by a calcareous stem; and the latter following the Pentacrinoid through the successive phases of its existence, to its detachment and subsequent full development into the free *Comatula*. The results of their researches, embodied in the successive communications made by them to the Royal Society, have not only shown how these creatures lived and moved, but have furnished (as they anticipated) valuable guidance to all subsequent investigators into the Palæontological history of the *Crinoidea*. And they have also served as the basis of the more minute anatomical inquiries of Ludwig, Greef, Perier, and Dr. P. Herbert Carpenter; which, prosecuted with every advantage afforded by improved methods of microscopic examination, have confirmed Dr. Carpenter's correction of several serious errors in Müller's anatomy; whilst his important determination, both anatomical and experimental, of the principal nervous system in *Crinoidea*, has been recently put beyond all doubt (though long contested as morphologically impossible) by the further experiments of Prof. A. M. Marshall and Dr. Jickeli (see p. 407 *et seq.* of Dr. P. H. Carpenter's Report).

Prof. G. O. Sars's discovery, in 1864, on a bottom of from 400-500 fathoms' depth, of the singular little stalked *Crinoid* to which he gave the name *Rhizocrinus lofotensis*, was followed by the discovery, in the *Porcupine* Expedition of 1869, of a new and delicate Crinoid belonging to the same family, named *Bathycrinus gracilis* by Wyville Thomson, who brought it up from 2435 fathoms' depth in the East Atlantic; a second species of *Rhizocrinus* being also met with. And in 1870 a fortunate haul made by the *Porcupine* in 800-900 fathoms off the coast of Portugal, brought up twenty specimens of a full-sized new species of *Pentacrinus*, called by Dr. Gwyn Jeffreys (who had charge of that cruise) *P. wyville-thomsoni*.

About the same period, the United States Coast Survey

brought up both *Rhizocrinus lofotensis* and the second species, *R. rawsoni*, in the West Indian Seas; while Sir Rawson Rawson, Governor of Barbadoes, who had been interested in the work by Dr. Carpenter, obtained three specimens of the singular genus *Holopus* (previously known as a recent type by only a single specimen so imperfect that its crinoidal nature was doubted), and several *Pentacrini* belonging to species which had been previously obtained for Wyville Thomson by Mr. Damon's collectors in the same region.

This was the sum of our knowledge. alike of types and of localities, when the *Challenger* Expedition set forth in 1872. The collections made during her voyage, supplemented by those made in the West Indian area by the U.S.A. surveying-ship *Blake* (types of which were placed by Prof. A. Agassiz in the hands of Sir Wyville Thomson for description), and a few gatherings from other sources, now raise the total of existing generic forms to 6, and of species to no less than 32; at the same time demonstrating the very wide diffusion of the stalked Crinoids over the oceanic floor, and showing their bathymetric range to extend from depths of less than 100 fathoms to 2500. A large collection was also made by the *Challenger* of unstalked *Comatulidæ*, including the singular aberrant genus *Actinometra;* together with a single specimen (recently described by Dr. P. H. Carpenter[1] under the generic designation *Thaumatocrinus*) of an unstalked type which presents a most singular survival of Palæocrinoidal characters.

Finding, on his return from the *Challenger* Expedition in 1876, that Dr. P. Herbert Carpenter had been further prosecuting the study of the *Comatulidæ*, on the basis laid down by his father, Sir Wyville Thomson placed in his hands the whole *Challenger* collection of unstalked Crinoids, which included not less than 150 new species; keeping in his own charge the collection of stalked Crinoids (together with the types of the *Blake* collection), on which he intended himself to report. This intention, however, he did not live to fulfil; and on his untimely death in March, 1882, Mr. Murray requested Dr. P. H. Carpenter to undertake the stalked Crinoids also. Beyond naming (mostly without diagnoses) several new genera and species, and directing the execution of 28 plates, Sir Wyville Thomson had made no preparation whatever for his Report; and on his successor, therefore, almost the whole labour of its production has fallen. The result has fully justified Mr. Murray's selection; for we feel sure that in proportion to the previous knowledge possessed by any student of this Monograph, will be his admiration of the masterly skill with which the knowledge derived from the careful and thorough study of every existing type at present known is made to elucidate the structure and life-history of the extinct Crinoids: this being no less apparent in the case of the *Palæocrinoidea*, which differ most widely from existing forms, than in that of the *Neocrinoidea*, many of which are represented in our existing fauna by forms that differ from them only specifically. In this, his *opus magnum*, will be recognised that combination of a remarkable aptitude for the apprehension of details, with a philosophic grasp of his subject as a whole, by which Dr. P. H. Carpenter's previous contributions to its literature have been distinguished; making him equally at home in characterising a specific type, in working out the minutest features of its organisation, and in discussing the homologies of the *Crinoidea* with those of the other divisions of the great Echinoderm group. Whilst giving the fullest credit to his predecessors and contemporaries, he has endeavoured to determine every point for himself; frequently clearing up an obscurity, or satisfactorily settling a disputed question, by more extended research of his own. And where he has found his own inferences from the study of existing types to disagree with those of Palæontologists who had acquired a deserved reputation for their labours on the fossil Crinoids, he has set forth the grounds of their opinions, and his own reasons for dissenting from them, with impartial fairness. This is conspicuous in his discussion of the morphological relations between the *Neocrinoids* and the *Palæocrinoids;* as to certain points of which he is at issue with the highest authority upon the latter group, Mr. Charles Wachsmuth, of Burlington, Iowa, U.S., which locality seems its metropolis. "We have approached the subject," he says, "from different sides; but upon one point we are in complete accordance—viz. the desire to find out the truth."

[1] *Philosophical Transactions*, 1883, p. 919. and "Report," p. 370.

The *first* division of the Report, extending to 185 quarto pages, is devoted to the Morphology and Natural History of the *Crinoidea* generally, treated under the following heads:—(1) The skeleton, with the modes of union of its component joints; (2) the stem and its appendages; (3) the calyx; (4) the rays; (5) the visceral mass; (6) the minute anatomy of the disk and arms; (7) the habits of recent Crinoids, and their parasites; (8) the geographical and bathymetrical distribution of the Crinoids; (9) the relation between the recent and the fossil Neocrinoids; and (10) the relations of the Neocrinoids to the Palæocrinoids. All these subjects are treated with a completeness which leaves nothing to be desired; rendering this portion of the work a most admirable Introduction to the study of the *Crinoidea* generally, without a thorough mastery of which no one can henceforth be qualified to discuss any portion of the group.

The *second* division commences with a discussion of the principles on which the Classification of the *Crinoidea* should be based; after which, every type of Stalked Crinoids at present known is fully described, and its relations discussed. A few of the most interesting additions to our previous knowledge will be briefly noticed as samples of their value.

The structure of the strangely aberrant *Holopus*—in which the basal and radial plates are completely anchylosed into an asymmetrical tube-like calyx, fixed by an irregularly expanded base, while the arms are exceptionally massive—is elucidated as fully as the state of the specimens permitted; and it is shown that not only the Cretaceous *Cyathidium*, with the Liassic *Cotylecrinus* and *Eudesicrinus*, which had been previously referred to the family *Holopidæ*, but also the Upper Silurian *Edriocrinus* of Hall, are to be associated with it; so that the pedigree of this family seems more ancient than that of any other recent type at present known.

The new genus *Hyocrinus*, instituted by Wyville Thomson for a beautiful little deep-sea Crinoid bearing a superficial resemblance to *Rhizocrinus*, is shown by Dr. P. H. Carpenter to have distinctive characters of such a

rank as to require being ranked as a type of a new family, which, while not specially related to any other Neocrinoid, presents important characters that connect it with the Palæocrinoids.

The *Bathycrinus* of Wyville Thomson, of which three species are now known, and the *Rhizocrinus* of Sars, of which the two species now known prove to have a wide geographical distribution, are next minutely described as members of the family *Bourgeticrinidæ* (De Loriol). This family represented in the Cretaceous and Tertiary epochs the much more highly developed *Apiocrinidæ* of the Jurassic; and there seems every probability that we can now correctly reconstruct the whole anatomy of the Pear Encrinite on the basis supplied by Ludwig's study of the soft parts of *Rhizocrinus*, and Dr. P. H. Carpenter's account of those of *Bathycrinus*.

We next come to *Pentacrinus*, the typical genus of the family *Pentacrinidæ*, as this is the typical family of the *Neocrinidea*. Every palæontologist is familiar with the extraordinary development of this family type in the Liassic period, as shown in the splendid slabs exhibited in our museums. The most remarkable species, as regards the length of its stem and the number of the component joints, is *Extracrinus subangularis*: fossil specimens of whose stem have been found to measure from 50 to 70 feet. The mode in which the new joints are added at the summit of this stem was studied by Quenstedt, as well as the fossilised condition of his specimens permitted; but Dr. W. B. Carpenter has been able to work it out more completely in the recent *Pentacrinus wyville-thomsoni*; and the excellent figures drawn by Mr. George West for the illustration of a monograph of that type which Dr. Carpenter formerly intended to produce, show every successive stage in the development of the segments intercalated at and near the summit of the stem, the gradual assumption by the intercalated segments of the characters of those with which they alternate, and the progressive change from a pentangular to a circular outline, as well as in their articulating surfaces, which both series finally undergo; thus making it clear that great care must be used in erecting new fossil species (as has been frequently done) upon the slender evidence of an inch or two of stem.

Of the genus *Pentacrinus*, the three species which had been obtained from West Indian Seas before the discovery of the European type, had been so variously named and so diversely described, that their synonymy seemed in a state of hopeless entanglement. By a careful comparison, however, of the best-authenticated specimens of each with the large number since collected, Dr. P. H. Carpenter has found himself able to clear up the confusion; this having partly arisen from the wide range of individual variation, especially in a character hitherto regarded as of fundamental importance—the completeness of the basal circlet, and its external conspicuousness, as well as in the number of arms to each ray. The first-known species, originally called *Isis asterias* by Linnæus, now proves to be the rarest; several of the Museum specimens which had been referred to it, being here shown to belong to the species first distinguished by Œrsted in 1856 as *P. mülleri*. Greatly exceeding both these in abundance, is the elegant species originally named *P. decorus* in 1864 by Wyville Thomson, who had obtained a specimen of it from Mr. Da[illegible]on; the dredgings of the U.S.A. steamer *Blake* in the Caribbean Sea and the Gulf Stream Channel having brought it up *by the hundred*, so that, as Prof. Agassiz remarks, "we must have swept over actual forests of Pentacrini crowded together, much as we find the fossil Pentacrini on slabs." Another species, *P. blakei*, was dredged by the *Blake* at four stations in the Caribbean Sea; and neither of these four species has been met with elsewhere. Of the *P. wyville-thomsoni*, which first presented itself in the *Porcupine* dredging of 1870, thirty specimens were recently dredged by the *Talisman* (French) at a depth of 800 fathoms off Rochefort; but it was not anywhere met with by the *Challenger*, which, however, brought up a specimen of a beautiful new species, *P. maclearanus*, from the Tropical Atlantic, several specimens of two types respectively named *P. naresianus* and *P. alternicirrus*, from the Western Pacific, and a single mutilated specimen from the Japan Sea of a doubtful type, which, on account of the deficiency of calcareous material in its calyx, Dr. P. H. Carpenter provisionally names *P. mollis*. All these species appear to have but a limited geographical range; and this seems also to have been the case with the fossil species of the Lias, the British and Continental species being mostly different. These, too, have a limited geological range; no species occurring in all its three divisions, and only two out of the fifteen which are found in the middle and upper Lias of this country being common to those two divisions.

Of all the stalked Crinoids, it is *Pentacrinus* (as was seen by J. S. Miller) which bears the closest resemblance to the unattached *Comatula*; the chief difference being that the basals of the pentacrinoid larva are retained in the adult *Pentacrinus*, whilst they disappear externally in *Comatula*, inward prolongations of them coalescing to form the curious "rosette" first described by Dr. W. B. Carpenter. In regard to their mode of life, there seems really very little difference between these two types; for observation of the habits of living *Comatulæ* shows that they only perform their beautiful swimming movements in order to find a suitable base to which they can attach themselves by their dorsal cirri; whilst on the other hand it seems quite certain that the stalked *Pentacrini* are not unfrequently detached by the fracture of their stems just below one of its nodal joints, and that the cirri which spring from the latter then bend downwards and cling to any suitable attachment, just like the dorsal cirrhi of *Comatulæ*. The structure of the visceral disk as well as of the arms and pinnules of *Pentacrinus*, has been found by Dr. P. H. Carpenter to bear the closest similarity to that of the corresponding parts in *Comatula*: and while the five-chambered organ at the base of the calyx, from the walls of which the primary nerve-trunks radiate, is much smaller in *Pentacrinus* than in *Comatula* (its greater size in the latter being obviously related to the number of verticils of cirral nerve-cords it has to give off), a similar dilatation of the Crinoidal axis presents itself in each node of the stem, giving off from its exterior a single such verticil.

It is not a little curious that in the Eastern Archipelago and the neighbouring part of the Pacific, *Pentacrinus* is replaced by a new generic type, closely allied to it in the most essential features of its structure, to which Sir

Wyville Thomson assigned the name *Metacrinus*, though without defining its distinctive characters. No fewer than eleven species of this genus were dredged by the *Challenger;* and, previously to his receiving this collection, Dr. P. H. Carpenter had come to the knowledge of three other species, a description of which he has communicated to the Linnæan Society. All these seem very limited in their geographical range, and not one of them has been found in the Atlantic. No fossil representative of this genus is at present known ; but it is by no means impossible that some of the Liassic (reputed) *Pentacrini* may prove to belong to it.

In addition to the 28 plates drawn for Sir Wyville Thomson, and 5 of *Pentacrinus wyville-thomsonii* supplied by Dr. W. B. Carpenter, 35 plates have been drawn under Dr. P. H. Carpenter's direction, many of them containing numerous figures ; while another has been autotyped from micro-photographs prepared by himself ; making a total of 69 plates, for the most part admirably executed, besides 21 woodcuts in the text. When we add that the work is provided with a copious bibliography and an excellent index, we hope that we shall have made it clear that nothing, in our judgment, is wanting to its completeness.—The report on the *Comatulidæ*, of which the preparation was far advanced before it was put aside for that on the stalked Crinoids, will, we trust, speedily follow. We shall next look for the monograph of the *Blastoidea*, on which, it is understood, Dr. P. H. Carpenter has been for some time engaged, in conjunction with Mr. R. Etherege, jun., and which will, we believe, throw an altogether new light on that most interesting group. And every British Palæontologist, we feel sure, will desire that he may then find himself enabled to undertake, on the sure basis he has now laid, a complete review of the Fossil *Crinoidea* and a re-investigation of the little-understood *Cystidea.*

FRANKLAND AND JAPP'S INORGANIC CHEMISTRY

Inorganic Chemistry. By Edward Frankland, Ph.D., D.C.L., LL.D., F.R.S., Professor of Chemistry in the Normal School of Science ; and Francis R. Japp, M.A., Ph.D., F.I.C., Assistant Professor of Chemistry in the Normal School of Science. (London: J. and A. Churchill, 1884.)

WHEN one opens a new book on Chemistry written by men who are generally recognised to be masters of their subject, one expects to find some light thrown on the great and confused heap of details with which one is accustomed to be confronted in the pages of the ordinary chemical text-book.

Hydrogen, it is true, can scarcely be expected to have changed its properties since the last treatise on descriptive chemistry was published ; it still remains "a colourless gas devoid of taste and smell" ; it is still a fact that "owing to its lightness this gas may be collected in inverted vessels by upward displacement." No one will venture to dispute the assertions that "in the free state hydrogen occurs in the gases of volcanoes (Bunsen)," or that "in combination hydrogen occurs in enormous quantities in water." But we have heard these statements so very often. Are they not preserved for us in the pages of scores of books, and of tens of scores of pamphlets? Surely it is not asking too much from our masters in chemistry that they should begin to make some use of the many facts which have been so laboriously collected. The "hewers of wood and drawers of water" have brought the materials into the camp : must they lie there for ever unused ? They have been scheduled and catalogued a thousand times ; was it necessary or advantageous that Profs. Frankland and Japp should undertake the work of issuing another catalogue ?

The book before us contains 783 pages of printed matter ; of these, 650 pages are devoted to descriptions of the elements and their compounds. One cannot expect much in this part of the book, except a repetition of the well-known facts. The formulæ in this book are perhaps a little more picturesque than usual ; the judicious employment of thick type and small *o*'s, whether commendable or not from the chemical point of view, certainly gives an air of distinction to the page which the ordinary text-book is obliged to do without.

Turning to the introductory chapters, one is somewhat taken aback to learn on page 1 that cohesion, heat, light, gravity, chemical affinity, and electricity, are all forms of force. After learning this, one is certainly not surprised to be informed (pp. 64–5) that the formulæ

$$\begin{array}{c} H-C-H \\ \| \\ H_2 \end{array}$$

and $O=C=o$, "give no indication that the molecule of the first compound contains a vast store of force, whilst the last is, comparatively, a powerless molecule." This confusion between force and energy is painfully visible throughout the book. Is there something radically absurd in the attempt to apply dynamical notions to chemistry? If not, why is it that when a chemist commits himself to a statement involving the conceptions force and energy in nine cases out of ten he gets altogether confused ?

A great part of the advance made in chemistry in recent years is based on the adoption of clear and practical definitions of the atom and the molecule, and on the conceptions which flow from these definitions. Chapters IV., V., and VI. of Profs. Frankland and Japp's book deal with these subjects. Chapter IV. gives a clear and trustworthy account of the laws of chemical combination ; Chapter V. deals with the atomic theory in an exceedingly satisfactory manner ; and Chapter VI. presents us with a sketch of the methods whereby the molecular weights of gaseous elements and compounds, and the atomic weights of elements, are determined. These chapters appear to us to be especially good ; a careful study of them is likely to be of much benefit to the student of chemistry. But if the student be of a critical turn of mind, he may object that he should be shown the "steep and thorny way," while the authors themselves, in the other parts of their book, "the primrose path of dalliance" tread. Thus, to take an instance, the molecular formula of ferric hydrate is given (p. 59, *note*) as $Fe_2H_6O_6$; but ferric hydrate has never been gasified, and the theory of molecules as developed in Chapter VI. is a theory strictly applicable to gases only. Indeed, we might object to the incongruity between the teaching of Chapters V. and VI., and the practice of most of the book. These chapters define atom and molecule, and

give us the outlines of a self-consistent theory; but the chapters on descriptive chemistry employ the term "molecule" in the vaguest and widest way, *e.g.* (p. 67) these formulæ are given as molecular $(KO)_2$, (O_2Zn), $(NH_2)_2$, and these as semimolecular OK, $\left\{\begin{matrix} O \\ Zn \\ O \end{matrix}\right.$, NH_2.

Indeed, all through the book little or no distinction is made between the formulæ of gases and those of solids; all are treated as molecular. The disadvantage of doing this becomes very apparent when we turn to our authors' treatment of the much-vexed questions connoted by the term "valency" or "atomicity."

Here the reviewer would protest against the use of the term "atomicity" as synonymous with "valency of atoms." On p. 30 we are told that the molecules of hydrogen, oxygen, chlorine, &c., are diatomic, and the molecule of ozone is triatomic; if, therefore, we meet with the statement that oxygen is a diatomic element, we should naturally interpret this to mean that the molecule of oxygen is twice as heavy as the atom; but we find that it means something quite different: it means, according to this book, that oxygen has an atom-fixing power equal to twice that of one atom of hydrogen.

The treatment of valency, or equivalency, of atoms by Profs. Frankland and Japp is, in our opinion, open to the gravest objections.

The statement on p. 57 that the atomic weight of an element "is the smallest proportion by weight in which that element enters into, or is expelled from, *a chemical compound*" (italics are ours), we think, strikes the keynote of the confusion which immediately becomes evident. If for the words in italics are substituted the words, *a molecule of a chemical compound*, and if the definition of molecule, as given by Clerk Maxwell or other physicists and as practically adopted by our authors (pp. 26–7), is rigidly adhered to, the confusion, we are convinced, would vanish.

It may be said that the word 'molecule' is understood in the definition quoted, and also in the statements that appear on p. 57 and elsewhere—*e.g.* in the mutual action of zinc and steam, "one atom of zinc expels *from the steam* two atoms of hydrogen" (italics are again ours); but the frequent reiteration of the word would do something to restrain the chemical student from giving the reins to his fancy and plunging into dreams of graphic formulæ supposed to represent the structure of molecules, the existence of which is unproved.

Each element is said (p. 58) to have a certain atom-fixing power, and we are told "each unit of atom-fixing power will be named a bond." But when we come to study the formulæ which are constructed on this basis, we find that a bond is not a unit of atom-fixing power or of any other "power" at all. We find that an element with two bonds is simply an element one atom of which usually combines with two atoms of hydrogen or chlorine, &c., but the "power" cannot be measured by the number of atoms fixed. It is in our opinion altogether erroneous to speak of a "bond" as a unit of power, unless one is prepared to employ the term "unit" in a sense in which no known science has been bold enough to use it, and the word "power" in no particular sense at all.

The valency of many elementary atoms varies according to the nature of the other atoms with which they are combined in various compound molecules. The valency of an atom is, as a rule, expressed by an odd or an even number (there are more exceptions to this rule than the authors seem willing to admit on p. 60). "These remarkable facts can be explained by a very simple and obvious assumption, viz. that *one or more pairs of bonds belonging to the atom of an element can unite and, having saturated each other, become, as it were, latent.*"

One is obliged to ask here, Is this a scientific explanation? Does the explanation explain anything? What are these bonds which "become, as it were, latent"? Are not the facts much more "simple and obvious" than the explanation? What is the explanation?

Then we are told (p. 61) that "the apparent exception to this hypothesis [one asks, What hypothesis?] nearly all disappear on investigation. Thus, iron, which is a dyad in ferrous compounds as $(FeCl_2)$, a tetrad in iron pyrites (FeS_2), and a hexad in ferric acid $(FeO_2(OH)_2)$, is apparently a triad in ferric chloride $(FeCl_3)$; but the vapour-density of ferric chloride shows that its formula must be doubled—that, in fact, the two atoms of the hypothetical molecule of iron (Fe_2) have not been completely separated." Then follow structural formulæ (so called) of the iron compounds already named. If this is the kind of explanation that the bond hypothesis has to give of facts, we may well doubt whether any scientific advance is to be hoped for by using this hypothesis.

There is, it would seem, something metaphorical in the statement that when the bonds have satisfied each other they "become, *as it were*, latent" (italics ours): and "when a metaphor comes to be regarded as an argument, what an irresistible argument it always seems"!

One is so apt in chemistry to prove a fact by a hypothesis. We cannot but think that this method is too often followed in the book before us. For instance, the fact that water of crystallisation is generally easily removed by heating the crystalline salt, is explained (?) by the statement that "in the formation of such compounds no change takes place in the active atomicity of any of the molecules."

Great advances have been lately made in the study of chemical affinity. We turn with pleasure to Chapter XII., hoping to have our views on this subject rendered clear and definite.

Chemical affinity "may be measured as regards its *extent* and as regards its *intensity*." Relative extent of affinity is measured, we are told, by the number of atoms of a standard element with which two or more given elements (? elementary atoms) can combine. "*Extent of affinity* is thus directly connected with *atomicity*." "*Relative intensity of affinity* of two or more elements for any given element refers to the resistance which their compounds with this element offer to decomposition. The measure of this intensity is the quantity of heat evolved in combination or required for decomposition."

"Extent of affinity" seems to be here closely connected with the atom of the elements; we are left in doubt whether "intensity of affinity" is or is not similarly connected with these atoms.

The measure of the intensity of affinity seems to have something of the nature of an atomic bond, it is so very

protean; our faith in this measure is rudely shaken by the statements on pp. 104 5. There are many interesting statements in Chapter XII., but one finds it difficult to discover why the heading should be "Chemical Affinity."

The time is surely past when we are to expect the chemical student to be content with a sketchy outline of such subjects as affinity and thermo-chemistry. If these subjects are really parts of the science of chemistry—and surely they are all-important parts—let them be dealt with as such, and not thrust into a corner and treated so that the student is ready to conclude that, if he is able to repeat the properties of the elements and their compounds, he must of necessity be a chemist. The real science of chemistry is something more than a string of disconnected facts and a few mutually independent hypotheses.

We cannot but think that, had the authors of this book cut out most of the graphic formulæ, been content to use the notation adopted by other chemists, and carefully considered, digested, and arranged the materials they have brought together in the first nineteen chapters, they would have produced a much better and a much more scientific treatise. M. M. P. MUIR

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Mr. Lowne on the Morphology of Insects' Eyes

(1) IT is, I imagine, sufficiently obvious that I was not at liberty to state in my previous letter the circumstances connected with the action of the Royal Society in regard to Mr. Lowne's paper, now inaccurately related by him.

It is also clearly impossible that I should take any notice of Mr. Lowne's letter in your journal of April 9 (p. 528) beyond expressing my surprise that he should suppose that I have had any personal feeling in regard to him or his work, and my regret that he should accuse Prof. Schäfer, Dr. Hickson, the Royal Society, and the Cambridge histologists of ill-treating him in various ways.

(2) I would beg to assure my friend Dr. Romanes that he is mistaken if he imagines that I intend to publicly discuss the affairs of the Linnean Society with him either here or elsewhere. At the same time I consider that I am at liberty to express my judgment as to the scientific value of a paper published by the Linnean Society, and that neither he nor the author of the paper are entitled to object to my discharging what I conceive to be my duty in this respect. E. RAY LANKESTER

11, Wellington Mansions, N.W.

Abnormal Season in the Niger Delta

As you are aware the waters of the Nile are at present abnormally low, and having just received a letter from the Niger, I thought it might interest you to learn that the season is abnormal also there. My correspondent, who has an experience of many years on the river, states:—

"We have had the most extraordinary weather since the commencement of the year—heaps of rain up to the present during both months (January and February), and yesterday one of the worst tornadoes I have ever seen, and that from the due north; usually the bad ones come about Christmas from the south-east. I never saw rain, up to the present, after Christmas during the first three months of the year, which are the unhealthy ones. These months are this year so far fairly healthy, although the falling of so great a river as the Niger must wash down a mass of filth, not so much from the towns on the banks as from the hundred small and large villages and towns up all the creeks or tributaries along its banks."

I have asked if any barometer observations are made, and if I could have a return of them for the past year.

J. P. O'REILLY

Royal College of Science for Ireland, Stephen's Green, Dublin, April 16

Tardy Justice

YOU well advocate the establishment of a well-endowed scientific University in London. Perhaps, however, London is like a mass of dough which needs leaven. Why should not the Corporation of the City of London be that leaven? Perhaps, however, the Corporation needs that some one should employ a yeast-germ in order to start its fermentation. Or, if it be lawful to compare that august body to a pump, perhaps a handle is necessary which some one may work. Why should not the yeast-germ, or the handle, be found in Gresham College?

April 17 Z.

A Query

I WONDER if any of your readers could suggest a material which would fulfil the following requirements:—(1) Great cheapness; (2) capability of being readily cast, or moulded, into simple shapes with no delicacy of detail; (3) not very brittle; (4) not fusible under a temperature of 100° F. It should also afford a surface which could be readily painted, and it should not be too heavy, a specific gravity not much in excess of water being the best. India-rubber I find answers all requirements sufficiently well, except that it is much too expensive a material.

April 17 M. X.

The Use of Artificial Teeth by the Ancients

THIS is not a new discovery, as stated in *Cosmos* (see NATURE, April 16, p. 564). Cicero, De Legib. II., 24, quotes a law from the Twelve Tables forbidding the combustion or burial of costly golden articles, but allowing an exception in favour of "teeth fastened with gold" (*Quoi auro dentes vincti escunt, &c.*).

Heidelberg, Germany, April 18 O. S.

Far-Sightedness

A PANORAMA of the Alps, as seen from the Piz Langard in the Engadine, used to be sold, upon which Mont Blanc was figured, though some 3° distant. On a remarkably clear day this was pointed out to me, and I have no reason to doubt that I actually saw Mont Blanc at that distance. One morning I was walking on the terrace in front of Mr. Leland Cossart's house in Madeira, at an elevation of close upon 2000 feet above the sea, when the conversation turned on far-sightedness, and I pointed out two specks on the horizon as vessels. This they proved to be, when my friend informed me that no vessels had before been made out on the horizon from that position, even with the telescope. J. STARKIE GARDNER

7, Damer Terrace, Chelsea, April 17

AIMS AND METHODS OF THE TEACHING OF PHYSICS [1]

THE United States Bureau of Education has recently employed Prof. Charles K. Wead, A.M., Acting Professor of Physics at the University of Michigan, to draw up a set of inquiries respecting the teaching of physics and to collate and discuss the answers received. The results of his labours are now before us in a rather unusually lengthy circular issued by the Bureau. They are drawn from seventy replies to a set of questions sent to a selection made by the Commissioner of Education of masters of schools of various grades in the United States, compared also with information gathered from England and other countries. A table at the end showing as clearly as can be done in a word or two under each heading the tendency of each answer, makes it easy to

[1] "Circular of Information," No. 7, 1884, of the U.S. Bureau of Education. (Washington, 1884.)

see the points of difference and the correspondents who differ.

The replies seem to show:—

(1) A widely-spreading preference for science over literature or classics,—(*a*) as training of the mind; inducing habits of observation such as no study of grammar does, and consequently a great increase in what is called common sense, which close attentiveness soon spreads to other studies also, giving each observer who has caught the spirit of inquiry and learnt how to observe, compare, and draw conclusions himself, confidence in his own observations, instead of depending upon the authority of some book. It is well described from the master's point of view:—

"The advantages of the study have been: (1) Wonderful quickening of the intellect, lively interest in the school; (2) subsequent growth into the scientific and scholarly spirit, developing a wonderful ingenuity in mechanical contrivances and the manipulation of tools; (3) doubling (in some instances quintupling) the number of boys who take the high school course, and giving many a strong bent to industrial pursuits in their better-skilled departments. It has secured students of broader power of thought and generalisation. It has cultivated the senses so that pupils were not 'nature-blind.' It has trained to the habit of nice adjustment of probabilities, which has reacted with marked power in giving a critical acumen in classical research" (p. 16).

Since, therefore, it is our middle and higher classes who have to look to their brains for their success in life it is they specially who want this training in scientific method which will "teach them how to learn, not what to know."

(*b*) As valuable information—valuable first from a utilitarian point of view:—

"When one reflects how few persons there are who know the composition of a drop of water or a grain of sand in comparison with those who are familiar with a Latin verb or a Greek preposition, and how much each of these separate classes of educated people is accomplishing, it seems plain to me that instruction in physics is of the utmost importance to our people; for, beyond all doubt, scientific men have done, are doing, and will do more for the advancement and well-being of our country than any other class of her citizens" (p. 50).

And from this same point of view *any* scientific information is valuable to children who leave the elementary schools early in life, though it is generally urged that stuffing them with incoherent facts is a most useless education, and that what information is given must, therefore, form part of a scheme for teaching them observation. The American Association for the Advancement of Science protests aga nst any way of *giving* them information; they must *get* it.

Such information, however, is also rising in value as an accomplishment, and the lack of it will soon be looked upon as an ignorance of classics was a generation ago. It will be felt that "no knowledge of language can atone for an ignorance of nature," and that a neglected *h* or a false quantity is a very venial offence compared with wondering why eclipses never take place when the moon is half full.

2. That in the lowest schools, lessons on the elements of science should be given: examples being taken as much as possible from the most familiar toys and other objects about them. Experiments with such things are urged, because they are a fascination to the young, and a relief from committing Latin Grammar to memory. But the desirability of making this instruction the preparation for the higher classes is met by the fact that so few go on to them, and it seems clear that something more exact and systematic should be commenced among those who do go on; for, unless this is done, although a boy may have acquired some general notions of the terms and subject-matter, yet if fundamental points have been neglected in the lower schools, either the college class must be kept back to study these points, or he must build all his advanced work on an uncertain foundation.

(3) A further divergence is found on the question of experiments. A successful experiment is a great power for good, but it is a gift to be able to make experiments accurately and successfully: and, if the experiment fails, the faith in all teaching connected with it is shaken; still less can it be made the basis of fresh conclusions. Imperfect experiments, therefore, are an unmixed mischief, and for elementary classes all should be done by the teacher, who, besides a good general knowledge, should have some manual skill in using or even in making apparatus: "otherwise mistakes in method and fact will be common in his teaching, and his instruction will be a constant appeal to the text-book or other authority, thus losing the very thing that is of peculiar value in the training derived from the study of science." If the higher school students are put to experimenting when unqualified for it, and with inadequate means, habits of slovenly experimenting and inconsequent induction are formed, or the student is disgusted with the unsatisfactory nature of the whole thing.

(4) In the upper grades, however, and among specially gifted boys the value of experiments both by teacher and scholar is insisted upon almost as uniformly as it is among those who study the science of teaching and the teaching of science in England. "No support is given to the notion common among men of a literary education that physics can be learned as history is, by reading a book. Experiments are essential to the study, and to profess to teach physics without providing suitable experiments in sufficient number to illustrate the subject must be considered as a case of false pretences." Learning science by experiments draws out powers of the mind that school-teaching of every other kind, involving as it does unquestioning submission to authority, completely numbs. The exact observation of facts and, on the one hand, the bringing those into relation which had seemed unconnected, and, on the other hand, the loosening of independent facts that wise saws have placed in close relation; in a word, discovery, with its necessary companions, self-reliance, independent thought, shrewdness of judgment—the very qualities which make a successful man of the world—are all developed by experimental science instead of the too frequent opposite effect which makes anxious business fathers dread too much schooling for the sons who will have to follow them.

(5) Parallel to (3) and (4) are the conclusions drawn as to making apparatus. Bad apparatus induces imperfect experiment, and, as laboratory work must be serious and yield visible results or it will be despised, the apparatus for the students' use must not be flimsy, or in the nature of a plaything merely. It is therefore penny wise and pound foolish for a teacher to make his own apparatus. If his time is worth anything his productions will cost more than the more perfect work of an instrument maker; and, besides the great chance of imperfection from the beginning, it will be liable to such faults as warping, and, moreover, not likely to suit the next teacher. On the other hand, such a general rule as this is not intended to tie the hands of gifted teachers who can make everything that comes in their way their slave to answer their questions. There is a rapid descent from such to the plodding worker who teaches for daily bread.

The most difficult question to answer confidently, after taking the opinion of so many doctors, is whether teaching of any use to elementary schools can be made without serious disadvantage to form part of a course pursued further by the higher classes. The Circular finds unanimous agreement among the United States teachers that it is most desirable; and, after quoting English opinions that

our Universities ought to be able to frame such a course, urges that a committee of teachers who have carefully considered the evidence here supplied should be able to draw up a practical scheme sufficiently definite, detailed, elastic, and progressive to secure its wide adoption. Unless this is done, a teacher's work cannot be measured, and he will get neither credit nor cash for it from his judges; and no amount of public opinion will really make such teaching general while this remains so. A good practical suggestion in accordance with these conclusions is that some experienced teacher should devote his power to the preparation of cheap leaflets, not stitched together, for a brief inductive course, from which each teacher might select a series according to his circumstances. W. ODELL

THE WORK OF THE U.S. SIGNAL OFFICE UNDER GENERAL HAZEN[1]

THE recent examination by the joint commission of General Hazen and other witnesses, as to the efficiency and economy of the present administration of the Signal Office, is said to have brought out several statements as to the character of the work done by the Weather Bureau, and the progress made by it during the last few years. The following is a brief summary of these, and especially of Prof. Abbe's statement showing the status and work being pursued during the present fiscal year:—

The Signal Service employs 1 chief, 14 second lieutenants, and 500 enlisted men, of whom 150 are sergeants, 30 are corporals, and 220 are privates, but all generally known as Signal Service observers. These 515 persons constitute the Signal Corps proper: but 6 officers detailed from the line of the army are also temporarily attached to the service; and these have control of the disbursements, the property, the weather-predictions, the display of signals, the testing and comparison of instruments, the arctic stations, the international bulletin, the monthly weather review, the Pacific Coast section, and other main divisions of work.

These 6 officers, by the operation of the present laws, are being diminished in number by 2 annually, their places being filled by promotions from among the sergeants of the corps; so that in a few years the service will employ only officers and men of the Signal Corps proper. This elimination of officers who have had from ten to twenty years' experience in the Signal Service and the army is somewhat deprecated by General Hazen, who is very naturally loath to lose their services, while they themselves are loath to go; although it is evident that the corps proper already contains abundant and excellent material for the future needs of the service.

The Signal Service also employs a number of civilians —namely, 2 chief clerks, several clerks of lower classes, and a scientific staff of 3 professors, 4 junior professors, and 1 bibliographer, and a large number of civilian observers, printers, messengers, artisans, &c.—at various points throughout the country. The number of civilian *employées* at the central or Washington office is 64, all of whom give their whole time to the work. The total of those employed at other stations is apparently much greater than this; but each is employed only a short time daily, and most of them receive but 25 cents per day for some one special observation and record. The enlisted men of the service occupy about 200 stations scattered throughout the United States, including Alaska, at an average distance of 200 miles apart. About an equal number of stations are also occupied by civilians, observing the height of water in the rivers, or displaying storm-signals. From about 4500 other civilian observers reports are received gratuitously by mail on weekly or monthly forms. These observers are classified about as follows: voluntary land observers, 270; voluntary marine observers, 480; international observers, 330; Canadian observers, 18; state weather service, 450; tornado observers, 1200; thunderstorm reporters, 2000.

[1] From *Science*.

The following are some of the more prominent and important steps of progress taken during General Hazen's administration:—

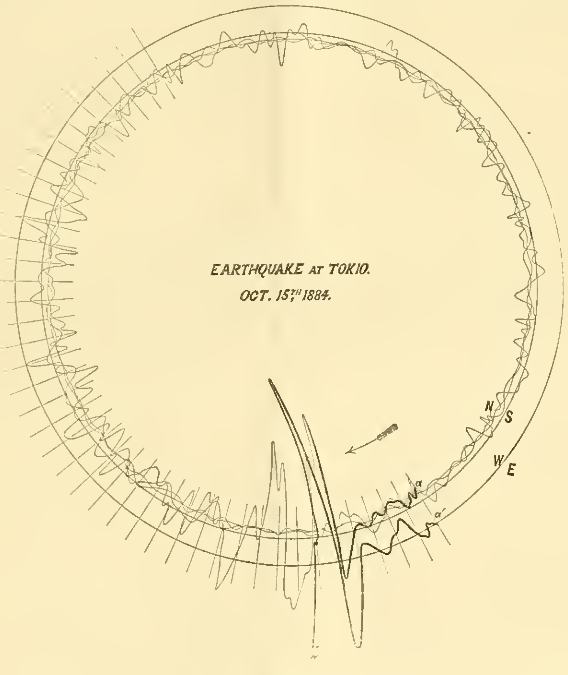
The introduction of consulting specialists and civilian experts in the available working force of the office; the assignment of selected sergeants and privates to work demanding a higher education and special aptness for investigation or study; the organised study of tornadoes, thunderstorms, atmospheric electricity, and other important novel fields of meteorological study; the introduction of weather-signals upon railroad-trains for the benefit of the farmers, and of local town-signals for the benefit of each community; the establishment of more severe rules for the verification of predictions, so that the 85 per cent. claimed at present means much more than it did a few years ago: the enlistment of a higher grade of men, the improvement of the courses of instruction for men and officers, the compilation of a working index to the literature of meteorology and the signal-office library, the organisation of new divisions in the office, especially of the study-room, the physical laboratory, the marine division, and the examiner's division; the publication of a monthly summary of international simultaneous observation, with a weather-chart showing especially the storms on the Atlantic and Pacific Oceans that affect the United States; the special study of atmospheric moisture with a view to improved methods of determining this factor; the special study of the exposure of thermometers, and correct methods for determining the temperature of the air; the maintenance of two polar and several auxiliary stations in pursuance of an international system for the study of the meteorology of the Polar regions: the adoption of many of the recommendations of the European International Meteorological Congresses looking to uniformity of methods throughout the world; the adoption of improved methods of reducing barometric observations to sea-level; the stimulus given to the formation of State Weather Services (this great advance has been wholly due to Gen. Hazen, who has not hesitated to declare himself in favour of co-operation, and not monopoly; by his circulars and assistance over fifteen States have been led to develop minute internal systems for the study of local climate and the dissemination of weather-predictions); the stimulus given to higher scientific work by members of the Signal Service, by requiring and publishing professional papers, signal-notes, treatises, &c.; the addition to the Signal Office of a few experts in scientific matters, who are responsible for the proper conduct of work requiring special study; the establishment of a high class of standard instruments, and more exact methods for testing-apparatus furnished to the stations, thus assuring against any deterioration in the accuracy of the work through many years to come; the encouragement and co-operation in scientific work, bearing on meteorology, by outside parties, such as spectroscopy, the study of solar heat and atmospheric absorption, and the prosecution of balloon-voyages; the adoption of a uniform standard of time for all observers; the adoption of a uniform standard of gravity for barometric reductions; the introduction of new special cautionary signals for high north-west winds and cold waves; the extension of signal-service stations in Alaska for the proper study of storms that strike the Pacific coast, and are followed by the severe cold waves from Manitoba.

In the prosecution of these and other multifarious labours the signal-service certainly demands a high degree of organisation, discipline, and intelligence; and it is by no means clear that this can be obtained in any better way than by a proper combination of military and civilian observers and scientific men.

A RECENT JAPANESE EARTHQUAKE

AN unusually great earthquake was felt in and about Tokio on October 15, 1884. The annexed autographic record of it comes, with the following particulars, from my former assistant, Mr. K. Sekiya, who is now in charge of the seismological observatory of the University of Tokio. It was given by a horizontal pendulum seismograph of the kind recently described in NATURE (vol. xxx. p. 150), and it has many features in common with the examples of records shown on pp. 174 and 176 of the same volume. But in the present case the amplitude of the earth's horizontal movement far exceeds anything that has been recorded since observations of this kind were instituted in 1880.

The figure shows the record reduced to about one-third its actual size. The undulations on the inner circle have been traced by a pointer which registered the north to south component of motion, and those on the other circle by another pointer, which registered east to west motion. The pointers are prolongations of horizontal pendulums,[1] and trace their records on a revolving sheet of smoked glass, which in this example was started into motion by the earthquake itself, through the agency of a delicate electric contact-maker. The plate is driven by a clockwork train which, after starting, quickly reaches a steady rate under the control of a fluid friction governor. The speed of rotation was one revolution in 82 seconds; the short radial lines mark seconds during the first part of the disturbance. The record on the outer, or east to west circle, has been turned round so as to bring it into synchronism with the inner or north to south record, and the earliest motions are distinguished, in the cut, by the use of a somewhat heavy line. The records begin at *a* and *a′*



and are traced in the direction of the arrow, which is opposite to the direction of motion of the glass plate. At *b* the east to west record comes to an abrupt stop, owing to the displacement there having been so great as to carry that pointer off the plate altogether. The inner record extends over nearly four complete revolutions, showing that visible motions of the ground lasted for about five minutes. During the first half-dozen seconds, while both components were being registered, there is a tolerably close agreement of phase between the two, showing that the displacements were then not very far from rectilinear. The greatest motion in this part of the disturbance took place five seconds from the start; at that point the actual motion of the ground was 3·7 centimetres from east to west and 2·2 centimetres from south to north. [The displacement of the ground is multiplied four times, in the original record, or about one and a third times, in the reduced copy given here.] The two components taken together represent a movement of the ground, from one side to the other, of no less than 4·3 *centimetres*—a quantity which is in striking contrast to the "5 or even 7 *millimetres*" which, after three years' experience, I named as the amplitude to which in a Yedo earthquake the displacement from the mean position "occasionally rises" (vol. xxx. p. 175). So far as can be judged from the north to south component alone, the most violent motions were over in about ten seconds, but for some minutes afterwards the oscillations, though very much reduced, continued to exceed in amplitude almost any that I have recorded.

[1] See "Measuring Earthquakes" (NATURE, vol. xxx. p. 150), or a "Memoir on Earthquake Measurement" (Tokio, 1883, p. 22).

Fortunately, however, this earthquake was prevented from being excessively destructive by the unusual slowness of the oscillations. The period of the principal movements appears to have been not far short of two seconds. For a rough estimate of the greatest velocity and acceleration we may treat the 4·3 centimetres movement as simply harmonic, and we find for the greatest velocity 6·8 centimetres per second, and for the greatest acceleration 21 centimetres per second per second, or $\frac{1}{47}$ of g. If the amplitude of motion which was recorded here had occurred in conjunction with the more usual period of three-quarters of a second or so, the destruction would have been immense. The earthquake appears to have been felt over an area of about 20,000 square miles.

Mr. Sekiya writes:—"We are going to exhibit your seismograph in the Exhibition in London, to be held next May. I am sure we will get a first prize medal!" Whether Mr. Sekiya and the Tokio University authorities get their medal or not they should at least excite the admiration of readers of NATURE for the zeal and success with which they are pursuing the study of seismology.

University College, Dundee J. A. EWING

EARLY MATURITY OF LIVE STOCK

THE subject of the "Early Maturity of Live Stock" is, no doubt, bucolical in some of its aspects; but, like many other agricultural questions, it is of great national importance, and is closely related to scientific investigations of much interest. The age at which the live stock of the farm becomes sufficiently mature has been considerably reduced during the past hundred years, both by improved methods of feeding, and still more by the altered habit of the breeds of animals—that is, by their earlier maturity induced by the modern system of breeding. Most persons are aware that the "improved shorthorns" were the artificial creation of two eminent breeders, the Messrs. Colling; that the "improved longhorn" cattle and Leicester sheep were the result of skilful selection and inter-breeding by Mr. Bakewell; and that Mr. Ellman conducted similar "improvements" on the Southdown breed of sheep. All these operations upon the earlier types of animals were initiated in the last century, and they were so successful, from a practical point of view, that both bulls and rams were raised in price from about 5*l*. to 20*l*. respectively to 1000 guineas for single animals of high character and esteemed pedigree in the flocks and herds of Colling and Bakewell.

Other breeders have applied the same arts, and especially the principle of selection, to some of the other breeds, and their object has been earlier maturity. It is obvious that a farmer must adopt that course of feeding which is most economical, and as a certain amount of food is consumed every day by an animal for respiratory and other vital functions, it is evident that the sooner it is fit for the butcher the less total amount of food it will consume wastefully. In the manufacture of meat the food required by an animal for its own purposes may be regarded as waste; so that the importance of saving time in the process of fattening is evident. It is said, indeed, that one-half of the food given to an animal under ordinary circumstances is required for the support of life, and, if that calculation be correct, then a slow-maturing ox, or sheep, at four years old will have consumed twice as much food to produce the same weight as an animal of improved breed at two years old. The period of youth is the period of growth, when the muscles, bones, and other parts are in process of formation, and when the waste of food is necessarily less than it must be at a later period of life. For the sake of economy all animals should be fattened and finished when young, and therefore the question of "early maturity" involves an inquiry into the period of life when the domesticated animals attain their full maturity and development.

Prof. Low, in his "Domesticated Animals," and Mr. Youatt, the famous specialist, state that the ox and sheep in a state of nature attained complete maturity at from four to five years old, their permanent teeth being then complete. This was the stage they had reached about a hundred years ago, when the country was covered with woods and wastes, before the great inclosures, and before the turnip became a field-crop. Stall-feeding had not been introduced at that period, and summer beef, fed on the marshes and natural pastures, was the only beef, and was, for winter use, invariably salted. The scanty provender of those days retarded maturity and postponed the usual period of producing young by more than a year, compared with the present time. At this stage the great breeders took up their several subjects with results so marked, and, it may be added, so remarkable, that within a few generations the complete maturity both of sheep and cattle—except in regard to the permanent teeth—had been reached in three years instead of four. The epoch of three-year-old mutton had now been reached, and some persons perhaps may still remember that luxury of their youth; and, if so, they must be aware that it exists no longer. In our own experience we must confess to have found old mutton rather tough, and, while admitting that "the grapes are sour," we see no reason why old beef and mutton should be superior to old geese and other poultry, or old game. But, however this may be, the perseverance of modern agriculturists and the competition of Australia and America in our meat markets, have led to still further reductions in the ages at which animals are slaughtered.

The action of our leading agricultural societies attests that some very recent movements have taken place for the purpose of stimulating breeders and feeders in the saving of still more food and time by early maturity. There must be a limit in these matters. Sheep and cattle of massive build are less ephemeral than some creatures, and a certain amount of time must always be required by them before their periods of complete development and of reproduction of the species can be reached. In 1875, however, the Smithfield Club offered prizes for lambs, having previously confined their favours to sheep one year older at least. There is no rule without exception, and one particular breed of sheep has been incited by arts and wiles, and, for the sake of "Christmas lamb," to produce its offspring in November, and to do so permanently. Usually lambs appear in spring; the "cattle show" is held in December, and lambs at nine or ten months old are now expected to exhibit themselves as sheep of great weight. They have responded to the call in the most wonderful manner; they have not only outnumbered the other "sheep" in the show, but they secured the champion prize for the best sheep last year as well as the year before, and their weights have equalled those of the old sheep of other days, *i.e.* 16 and 18 Smithfield stone (8 lbs.), or $3\frac{1}{2}$ lbs. of mutton per week from birth!

Cattle under two years old were first admitted in 1880, and their achievements, too, have been astounding. Early maturity, in short, has reached a new and unexpected stage. It has certainly been hastened, and cattle are now as fit for slaughter at two years old as they were formerly at twice that age. It is worthy of note, from a scientific point of view, that the period of complete dentition, as it occurs in a state of nature, has not been much, if at all, altered. It is true that M. Regnault, the French scientist, discovered a bull at a cattle fair in France in 1846 with all the permanent teeth fully developed. He was led to investigate the effects of careful breeding and feeding in occasioning that precocious development which has been already described, and this, he says, "cannot be confined to any particular organs. If every one has not equally participated in it, at least they are all more or less affected by it. Above all, the digestive system, the part

called on to play an important part in producing such an aptitude for early development, since all must essentially result from the nature and action of alimentation, must be one of the first to undergo modifications."

We do not question this conclusion, but the teeth and horns seem at present to have been slightly influenced by the "improvements" we have been considering. It is true that the art of breeding can greatly modify the horns; it can, in fact, obliterate them in horned cattle, and produce them in the hornless breeds, but this is quite apart from early maturity, which does not necessarily modify to any great extent, or with any certainty, either the horns or the teeth. Occasional examples of a very early development of the teeth, such as M. Regnault describes, do sometimes occur, but they are so rare as to be regarded as abnormal, and the rule, with the improved as with the older breeds of cattle, is that they produce two permanent teeth at two years old, and two others each year till they are five years old, when they are, as farmers say, "full-mouthed." It is not improbable, however, that the not very unfrequent appearance of the first permanent teeth at less than two years old, as well as the irregular dentition of highly-bred pigs, are manifestations that further and future changes may still be anticipated. Among many useful agricultural pamphlets that have been issued from the office of *The Field*, it is stated that one will appear shortly on "The Early Maturity of Live Stock."

H. E.

THE BORNEO COAL-FIELDS

HAVING recently visited some of the coal-fields in the Island of Borneo, it may be interesting to your readers to know the result. The subject was one of special interest to me, and its investigation was one of the principal objects I proposed to myself in my travels in the East. Just before leaving Australia I had published in the *Proceedings* of the Linnean Society of New South Wales a complete history of the known coal flora of Australia, and a review of its geological position. The relation of the Australian to the Indian coal flora is well known. It seemed hardly possible that in Borneo, where such extensive coal-formations exist, but that some connecting link would be found between Australia and India.

The subject is very little known. The late Mr. Motley had the management of the Labuan Mines. His are the only writings on the age of the Borneo coal which are known to me. What he wrote is quoted by Mr. Wallace in his work on "Australasia." He regarded the beds as Tertiary, and the fossils as of species of plants and marine mollusca now living on the coast. He speaks of cocoa-nuts and the peculiar winged seeds of *Dipterocarpus* (so common in Borneo) being common also in the coal at Labuan. He thought that the beds evidently originated in the most recent times from masses of drift-wood brought down by the rivers and stranded on the coast, in the way the traveller sees so often repeated on the Borneo coast at the present day. He also stated that the Labuan coal was not, properly speaking, coal, but more like drift-wood partially bituminised.

Mr. Motley subsequently was killed by the natives at Banjermassim. It is now six or seven years since the mines at Labuan have been worked. I am not sure that he had the same impressions about the South Borneo coal as of the Labuan beds, but I think I am not far out in thinking that he regarded all Borneo coal-beds as belonging to one immense Tertiary formation.

There are few countries of the world, except, perhaps, Eastern Australia, where coal is so extensively developed as in Borneo. Thick seams crop out in innumerable places on the coast and on the banks of the rivers. In some of the streams of North Borneo I have seen water-worn and rounded fragments of coal forming the entire shingle bed of the channel. In some places, again, there are outcrops with seams of good coal 26 feet thick. The coal-formation is the one prevailing rock of the coast. It forms the principal outcrop about Sarawak. At Labuan, also, no other rock can be seen. Lining the banks of the Bruni River, I only saw picturesque hills of very old Carboniferous shale. All the grand scenery of the entrance to the port of Gaya is made up of escarpment of coal-rocks. At Kirdat it is the same, and so I might go on with a long list of coal-bearing localities.

Now, in such a large island as Borneo, with such a wondrous mountain system, it would be absurd to suppose that all this coal belonged to one age. We might as well suppose the same of the comparatively small islands of Great Britain, and yet what an error that would be. In Eastern Australia and in Tasmania, beds of coal of very different age lie close together. I have found the same in Borneo. Whether there is Tertiary coal or not in the island, I cannot say; but there is Mesozoic coal, and probably Palæozoic coal, and coals like those of Newcastle in Australia, whose position hovers between the true Palæozoic and the Trias. To begin with Labuan: the works there have been long since abandoned; the adits are partly filled with water, and the shafts have fallen in, so that it is next to impossible to explore the mine now. But there is plenty of coal and shale on the surface, and there are excellent sections on the sea-cliffs close by. The formation is a drifted sandstone with much false bedding. It contains not a trace of lime or any marine organism. Under the microscope the siliceous grains are seen to be rounded. I think it is an Eolian formation with lines of rounded pebbles of small size. The whole deposit is very similar to the Hawkesbury sandstone of Australia, which is of Oolitic age. In both formations there are roots and carbonised fragments of coniferous wood, in which the tissue is still to be traced. The coal on the surface is a truly bitumenised coal, very brittle, and like what we get in the same rocks in Australia. The few plant-remains I saw were not referable to any known genus; they were like Zygophyllites, and perhaps these are the plants which have been identified as wings of *Dipterocarpus*, which they remotely resemble.

I saw no marine fossil, and the absence of any lime in the beds makes one think that those which were discovered did not come from any of the strata which are exposed in section. Sir Hugh Low, who resided many years at Labuan, gave me some casts of marine fossils taken from the locality. They were casts not easily identified, and certainly not like any now existing of the coast. The molluscan fauna of the locality is that of the usual Indian Oceanic type, with a slight admixture of Chinese and Philippine forms. In all recent beach remains in these parts of the world there is a large admixture of urchins, corals, &c. The aspect of the matrix was not of this character. It was much more like a blue-clay such as we have in Australia above the Mesozoic coal.

On the whole, I am inclined to regard the Labuan beds as of Oolitic age, and not Tertiary. Of the value of the coal-seams I had no means of judging. The amount on the surface showed that there was plenty to be had. Labuan is a naval coaling station. Stores of coal are brought out from England at a great expense for the use of her Majesty's navy, and if the same thing could be got in the island the enormous advantages are obvious. I think it should be further tested.

About fifty miles away to the south-east is the mouth of the Bruni river. Here the rocks are quite of a different character and much older. They are sandstones, shales, and grits, with ferruginous joints. The beds are inclined at angles of 25 to 45 degrees. They are often altered into a kind of chert. At Moarra there is an outcrop of coal-seams 20, 25, and 26 feet thick. The coal is of excellent quality, quite bituminised and not brittle. The beds are

being worked by private enterprise. I saw no fossils, but the beds and the coal reminded me much of the older Australian coals along the Hunter River. The mines are of great value. They are rented for a few thousand dollars (by two enterprising Scotchmen) from the Sultan of Bruni. The same sovereign would part with the place altogether for little or nothing. Why not have our coaling station there? Or what if Germany, France, or Russia should purchase the same from the independent Sultan of Bruni?

The Sarawak coal beds I did not visit, but a collection of fossils was kindly sent to me by the Hon. Francis Maxwell, the Resident. I recognised at once well-known Australian and Indian forms, such as *Phyllotheca australis* and *Vertebraria*. These are entirely characteristic of the Newcastle deposits in New South Wales. The connection thus established between the Carboniferous deposits of India, Borneo, and Australia is exceedingly interesting.

I intend to publish in another form all the observations I have made on the coal formations of Borneo and their included fossils. The main result of all I have seen may be embodied in the following conclusions:—

(1) There are in Borneo immense coal deposits of very different ages.

(2) These formations extend from the Palæozoic to the Middle Mesozoic periods.

(3) The fossils from some of the beds are specifically identical with those of certain well-known forms common to India and Australia.

(4) The Labuan coals are probably of Oolitic age, and not connected with any marine formation, but apparently of Eolian origin.

J. E. TENISON-WOODS

Labuan, Borneo, November 25, 1884

THE PARIS CENTRAL SCHOOL OF ARTS AND MANUFACTURES

A RECENT article in *La Nature* describes the new buildings of the École Centrale des Arts et Manufactures. The school was founded in 1829 for 200 pupils by Dumas, Lavallée, Péclet, and Olivier. The buildings remained from that date until quite recently in the rue de Thorigny, but the want of space became more and more perceptible as the scheme prospered, and in 1874 the Council proposed that the old buildings should be abandoned, and new ones erected on a vacant plot of ground 6300 square metres in extent, the site of the old St. Martin's Market, which abutted on four streets. The principal advantage of this situation was that it faced the garden of the Conservatoire des Arts et Métiers, and was therefore within reach of the immense technical treasures of that establishment. The new buildings have

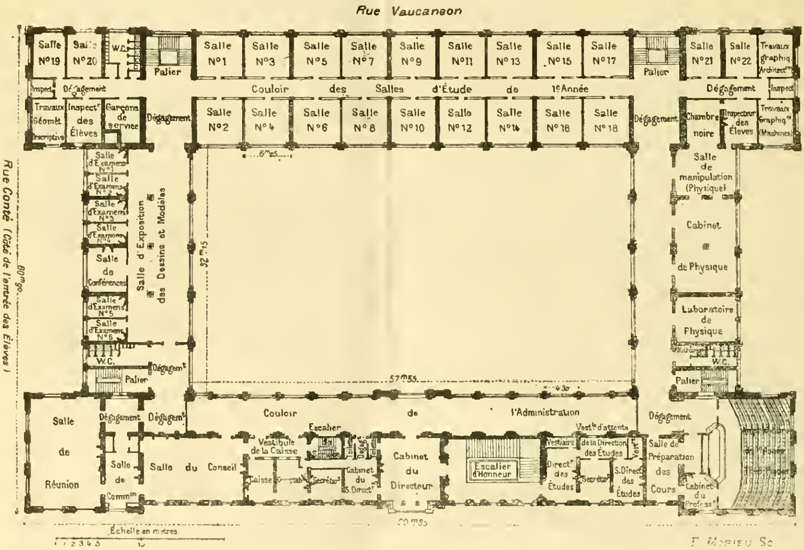


Fig. 1.—Plan of the New Central School.

a frontage of 99·60 m. and a depth of 60·90 m. They are rectangular, and inclose a large central court. The first floor is reserved for the administration and for the use of the first year's students, the second for the second year's, the third for the third year's, while the fourth and highest storey is reserved for the large laboratories. The basement and ground floor are used for the mechanical appliances, the kitchen, dining halls, the collections, and small laboratories for special purposes. Taking the building more in detail, and starting with the basement, we find that its galleries contain a line of rails with small trucks, presented to the school. It is used for conveying fuel to the furnaces, and vessels full of acid to the lifts, by which they are conveyed to the laboratories. The offices of the administration are heated by hot air on the Perret-Olivier system, the apparatus being presented by the makers, while the rest of the building is heated by hot-water pipes. The basement also contains the kitchens of the rival restaurants, which are farmed out, the gas-meters, and three large Geneste and Herscher generators for heat and ventilation. The boilers also work the engines necessary for the generation of the

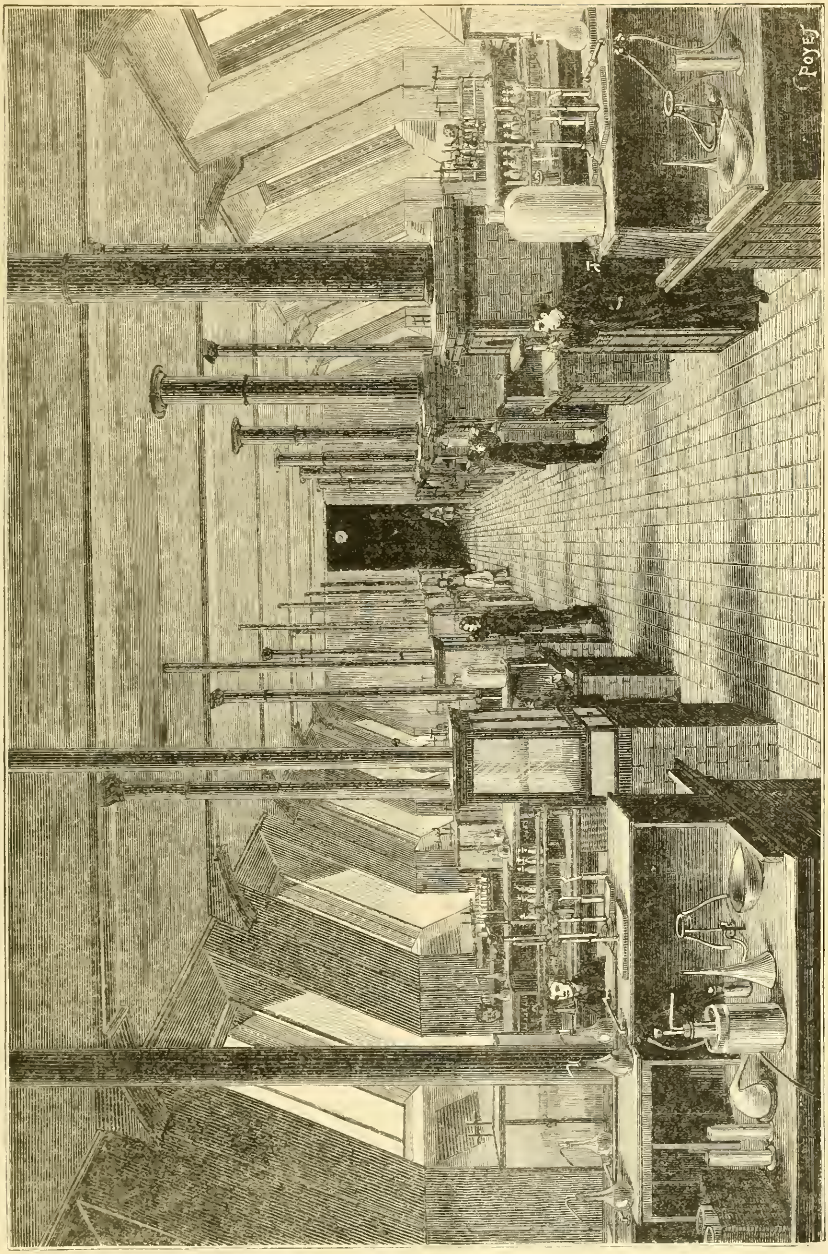


Fig. 2.—The New Central School: General View of the Great Laboratory or Third Year Students.

electricity employed for lighting purposes. The electrical works of the school are very remarkable. They include two engines, each of forty horse-power, which were presented by the makers. These work an Edison dynamo of 200 lamps, and three Gramme machines. The latter are each used alternately, and work six ventilators, which act over the whole building. Next to the electrical machines are two pumps which pump up water from a well; the school is also supplied with town water. Near the boilers is an Egrot alembic for distilling water for use in the laboratories. The steam from the water is conveyed by pipes into the laboratories, where it is employed in heating the water for washing, the stores, &c. In the basement are the cellars, store-rooms for glass, rooms for the study of stereotomy, for the construction of models, for stone-cutting, &c. The ground-floor includes a large court-yard, in the centre of which has been left the old fountain of St. Martin's Square. To the right of the entrance from the Rue Montgolfier is a staircase leading to a large vestibule, where the busts of the founders are placed. On this floor are the Mineralogical Museum, the dining-room of the Inspectors, stationery room, and the laboratory of industrial physics, the restaurants, the laboratory of industrial chemistry, and other special first year's laboratories, all opening on the court, the students working in the open air when dealing with noxious gases. The offices of the administrative body are on the first floor, and include director's and secretary's rooms, committee-rooms, steward's offices, and the like. These are lighted both by gas and electric light. The remaining rooms on the floor are devoted to students in their first year. Each storey has its large amphitheatre, capable of holding 250 students. These are formed at angles of the building, and are lit both by gas and electricity. The large blackboards behind the professors are raised and lowered by hydraulic machinery. The halls of study are ranged in two rows on one side of the building, with a corridor or passage between the rows for purpose of superintendence. Twelve pupils can occupy each room, and there are twenty-two rooms on each floor. The second and third stories are arranged on the same principle, except that on the former are the library and cabinets of collections. The fourth storey contains the large laboratories of the second and third year. The laboratory of the third year, of which an illustration is given, is the most important one in the school. Its appliances are of the most convenient and useful kind. Each student has all that he wants for his experiments at his hand.

NOTES

H.R.H. THE PRINCE OF WALES laid the first stone of the Museum of Science and Art and the National Library of Ireland on the 10th inst.

MR. RAPHAEL MELDOLA has been appointed Professor of Chemistry in the Finsbury Technical College in succession to Dr. H. E. Armstrong, who holds the Professorship at the Central Institute.

A SPECIAL general meeting of the London section of the National Association of Science and Art Teachers will be held at the Technical College, Cowper Street, Finsbury, on Saturday next, the 25th inst., at 7.30 p.m., when Sir H. E. Roscoe, V.P.R.S., President of the Association, will deliver an address on its objects. All interested in the teaching of science and art are cordially invited to attend. The above association was started in Manchester about three years ago for the purpose of advancing the teaching of science and art and improving the position of teachers. It already has strong sections in Manchester, Liverpool, Birmingham, Newcastle, and other large towns in the north, and the London section was started last year.

MCGILL COLLEGE, Montreal, has received, since September last, two donations from the Hon. Donald A. Smith, amounting in the whole to 24,000*l.* sterling (120,000 dollars), for the establishment of separate Lectures for Women, preparatory for the ordinary B.A. or an equivalent degree.

THE project for making Paris a seaport was brought before the Congress of Learned Societies on the 11th inst in a paper by M. Bouquet de la Grye. He said the subject was of importance from two points of view. The first and most important was the military one. The defence of Paris demanded imperatively the establishment of a port which would assure the victualling of the capital and its suburbs at all times. The commercial and industrial importance of the project is evident. The port should be established in the Poissy basin, and the Seine should be dredged to a mean depth of 6½ metres. M. de la Grye's system requires neither dams nor locks, but only the deepening of the bed of the river by dredging. It could be executed in four or five years. The total expense would be about 100 millions of francs.

DR. ROWELL, of Singapore, is stated to have made a valuable icthyological addition to the Raffles Museum there in the shape of a very complete collection of the fish and crustacea inhabiting the seas and rivers of the Malay Peninsula. Dr. Rowell, it is said, intends making a second similar collection to send to the Italian and Colonial Exhibition next year.

THE *Bulletin* of the Essex Institute (U.S.) contains a paper on American archæology, by Mr. F. W. Putnam, in which he refers to chipped stone implements. Referring to the statement often made that the making of arrowheads and similar objects is one of the lost arts, he says, that at the present time there are Indians in America who continue to manufacture them, and even work pieces of glass bottles into symmetrical and delicate arrowpoints. The method appears to be as follows:—A piece of stone is selected and roughly shaped by striking blows with a hammer-stone. If it is found to chip readily, it is shaped still further by light blows along the edges, each blow striking off a chip. Partly wrapped in a piece of skin, it is then held in the left hand and finished by flaking off little bits. This delicate part of the work is done with a flaking tool made usually of a piece of bone or antler. This is a few inches long, and about half an inch wide, having one end rubbed down to a blunt edge, which may be either straight, pointed, or notched. The other end is fastened to a piece of wood, so as to give a firm support to the hand. Sometimes this wooden handle is long enough to be held under the arm, thus steadying the implement which is grasped by the right hand. The edge of the flaker is pressed firmly against the edge of the stone, then with a slight rotation of the wrist a small flake is thrown from the edge of the stone. With a little practice this flaking can be done with considerable rapidity and precision. Some stones flake better after being heated. The various forms of chipped implements known as scrapers, drills, knives, spearpoints, and arrowheads probably were made by the method here described.

ACCORDING to the *Colonies and India*, Baron F. von Müller, K.C.M.G., has issued, under the auspices of the Victorian Government, a second supplement to his systematic census of Australian plants. It appears from the information now published that, whilst the known plants of Australia and Tasmania are about 9000, they occur in the following proportions in the respective colonies—viz. Western Australia, 3455; Queensland, 3457; New South Wales, 3154; Northern Australia, 1829; Victoria, 1820; South Australia, 1816; and Tasmania, 1023. The progress of botanical discovery in Australia within the last quarter of a century has been very marked, and the colonies are mainly indebted to Baron Müller for this result. In the beginning of the century (1805) Robert Brown, who may be called

the father of Australian botany, returned to England with between 3000 and 4000 species of plants, and these in subsequent years he described in his "Prodromus Flora Novæ Hollandiæ et Insula Van Diemen." From the days of Brown no systematic work was added to his labours, until Baron Müller, considering that the time had arrived for the publication of a general Flora of Australia, joined with the late Mr. Bentham in preparing and publishing the seven volumes of the "Flora Australiensis."

THE Lords of the Committee of the Council of Education have given their consent for a certain portion of the Buckland Museum Collection to be exhibited in the aquarium during the forthcoming International Inventions Exhibition. The selection will include casts of various species of fish, models of vessels, appliances for catching fish, and apparatus for marine and freshwater fish-culture. Such a combination of exhibits will prove a considerable source of attraction, and tend to popularise the aquarium still further in the eyes of visitors to the Exhibition. To no better purpose could the exceedingly interesting collection in the Buckland Museum be utilised, hidden, as it has hitherto been, from general observation by its remote situation at South Kensington.

THE National Fish Culture Fishery at Delaford is now partially in working order, and a large number of fry have lately been placed in the ponds, where they are thriving exceedingly well. This is the only *national* establishment in the United Kingdom constituted for the purpose of acclimatising and culturing fish for the benefit of all communities, including all species of Salmonidæ and coarse fish.

THE Zoological Society has been presented by the National Fish Culture Association with a young seal which has hitherto inhabited one of the ponds in the Exhibition grounds, South Kensington. It was captured off the coast of Donegal, Ireland, whilst in a state of somnolence.

THE current number (No. 17) of *Die Natur* contains an article by Herr Emmerig, of Lauingen, on German bees as storm warners. From numerous observations, the writer advances tentatively the theory that on the approach of thunderstorms, bees, otherwise gentle and harmless, become excited and exceedingly irritable, and will at once attack any one, even their usual attendant, approaching their hives. A succession of instances are given in which the barometer and hygrometer foretold a storm, the bees remaining quiet, and no storm occurred; or the instruments gave no intimation of a storm, but the bees for hours before were irritable, and the storm came. He concludes therefore that the conduct of bees is a reliable indication whether a storm is impending over a certain district or not, and that, whatever the appearances, if bees are still, one need not fear a storm. With regard to rain merely, the barometer and hygrometer are safer guides than bees; not so, however, in the case of a thunderstorm. Finally, the writer trusts that his remarks on this subject may lead to further observation.

MESSRS. SAMPSON LOW AND CO. announce that during the present month they will publish "Under the Rays of the Aurora Borealis, in the Land of the Lapps and Kvæns," an original work, by Dr. Sophus Tromholt, edited by Mr. Carl Siewers. Besides a narrative of journeys in Lapland, Finland, and Russia during 1882-83, and descriptions of the interesting Lapps and Kvæns, the book will contain an account of the labours of the recent circumpolar scientific expeditions and a complete popular scientific exposition of our present knowledge of the remarkable phenomenon known as the aurora borealis or northern lights, to the study of which the author has devoted the greater part of his life. The work will also contain a map, chromo-lithographs, and 150 views, portraits, diagrams, &c., from photographs and drawings by the author, including numerous illustrations of the aurora borealis. Arrangements have been made for the publication of the work in France, Germany, Norway, Sweden, and Denmark.

MISS E. A. ORMEROD'S "Report of Observations of Injurious Insects and Common Farm Pests during the Year 1884, with Methods of Prevention and Remedy," has reached us. This issue is the eighth annual report that has been prepared by the author, and is much more bulky than any of its predecessors, extending to 122 pages. It embodies the remarks of numerous observers in various parts of the United Kingdom on the occurrence of insects injurious to farm and garden crops, the extent of their depredations, to which is often added suggestions for prevention and remedy. In glancing through the pages of this report it is not a little remarkable to notice how observant often of minute and interesting details Miss Ormerod's correspondents are, and, though many of them probably have little or no scientific training, their aptitude for observing the habits and effects of certain insects makes their records of considerable value. Setting aside the value accruing from the publication of the report under notice, Miss Ormerod has done a good work in inculcating such habits of observation amongst farmers and gardeners, who have opportunities such as few others have for noticing facts connected with the life-histories of such insects as destroy their crops. The plan of Miss Ormerod's report is alphabetical, arranged according to the name of the plant attacked—such, for instance, as the apple, beans, birds (with especial reference to the depredations of sparrows), cabbage, carrot, &c. Into the matter of the sparrows Miss Ormerod goes at considerable length. She says: "The subject of the great loss caused by sparrows still needs to be brought forward. The injury continues to be widespread and serious, not only with regard to corn, but likewise in fruit-farming districts, and to garden crops; and, to encourage those who are suffering under it to bestir themselves actively in getting rid of the pest, it is desirable to draw attention to some points connected with it which deserve consideration—such as what the food of the sparrow is during the whole year besides the corn which we see it robbing us of; what its habits are; and likewise whether, where sparrows have been destroyed during a series of years in any given area, that area has been infested *with more insects* or *with more of any special kind of insect*, than when the sparrows were there." Miss Ormerod's numerous correspondents all agree that sparrows will not feed on insects when seeds, grain, fruit, and other vegetable food is within reach, and that, consequently, their numbers must be kept down if any farm or garden crops are to be harvested. Miss Ormerod is careful to point out that in advocating a judicious destruction of the house-sparrow, other small birds are not included. With regard to the appearance of starlings in large numbers in insect-infested pea-fields, a correspondent at Kingsnorth, Kent, observed that the weevil began to commit serious damage, and although the peas grew away from this attack, Aphis followed, and "starlings by hundreds frequented the pea-fields, as also did numerous kinds of smaller insectivorous birds, *but not the sparrows, until the pea was large enough for him to peck it out of the pod.*" Amongst other subjects more fully treated of in the Report, are the hop aphis and damson hop aphis, the willow beetle, and some special observations on the warble fly, or ox box fly. The report will prove of much value to farmers, gardeners, and those interested in vegetable growth, and is full of interesting facts of scientific value. It is published by Messrs. Simpkin, Marshall, and Co.

AT a meeting of the Asiatic Society of Japan held in Tokio on February 11, Mr. Eastlake read a paper on the Japanese poisonous snake, *Trigonocephalus blomhoffi*, called by the natives *Mamushi*. It ranges in length from a little over one foot to

nearly or quite two feet; the body is short and thick, the head triangular, half of it being covered by shields; the colour is earthy brown, with dark brown circular markings or spots; the belly is black, but the edges of the abdominal plates are whitish. The same snake has been observed in Japan, Formosa, Mongolia, Chihli, Sze-chuan, and Kiang-hsi. It is much dreaded by the Chinese, who give it several fanciful names; but its correct name is compounded of two ideographs meaning "worm" and "to strike," from the idea that it invariably inflicts two wounds. It derives one of its names ("only a day") from the notion that a person bitten by it lives only twenty-four hours. According to Kæmpfer, soldiers are fond of the flesh, and to this day it is highly esteemed as a febrifuge, and takes an important position in the Japanese pharmacopœia. The skin also is preserved as a talisman of singular efficacy. The popular belief is that the *mamushi* gives birth to its young through the mouth, but it is really oviviparous. It is said by one native encyclopædia that if the flesh be thrown on the ground the earth in the vicinity begins to hiss and steam, that the fat eats holes into everything it touches, that it is covered with bristles like a pig, is seven or eight feet long, carries a sting in its tail, and finally, that it should be eaten with "plum vinegar," or the leaves of the water-pepper. Taken thus, it cures irregular circulation of the blood and stubborn ulcers. The bite is seldom fatal, but when it is so, death occurs from circulation in the pulmonary arteries, producing asphyxia. As is the case with all *Crotalidæ* bites—for the *mamushi* is allied to the American rattlesnake, though far less venomous—the young can inflict poisonous wounds immediately after birth. The poison canal runs directly through the fang, while with many other snakes it simply lies in the groove of the fang. This tooth, or fang, may be compared with the needle of a hypodermic syringe; under the microscope it is flat, elliptic, sharp-pointed, and curved inward. In treating the wound, external applications are useless. In eating, the *mamushi* does not make use of its poison fangs, refusing even to eat anything that is killed with its venom. It is a reptile of nocturnal habits.

THE additions to the Zoological Society's Gardens during the past week include two Macaque Monkeys (*Macacus cynomolgus* ♂ ♀) from India, presented by Mr. A. J. McEwens, a Campbell's Monkey (*Cercopithecus campbelli* ♀) from West Africa, presented by Miss Lyster; a Wild Boar (*Sus scrofa* ♀), European, presented by the Rev. Horace Waller; an Emu (*Dromæus novæ-hollandiæ*) from Australia, presented by Capt. J. E. Erskine, R.N.; two Gouldian Grass Finches (*Poephila gouldiæ*) from Australia, presented by Mr. Chas. N. Rosenfeld, two Turtle Doves (*Turtur communis*), British, presented by Miss Reinhold; a Common Badger (*Meles taxus*), British, a Toco Toucan (*Ramphastos toco*), two Guira Cuckoos (*Guira piririgua*), a Brazilian Caracara (*Polyborus brasiliensis*) from Brazil, a Short-tailed Albatross (*Diomedea brachyura*) from Antarctic Seas, four Pintails (*Dafila acuta* ♂ ♂ ♀ ♀), European, four Summer Ducks (*Œx sponsa* ♂ ♂ ♀ ♀) from North America, two Spotted-billed Ducks (*Anas pæcilorhyncha* ♂ ♀) from India, deposited; two Summer Ducks (*Œx sponsa* ♂ ♀) from North America, four Mandarin Ducks (*Œx galericulata* ♂ ♂ ♀ ♀) from China, a Swinhoe's Pheasant (*Euplocamus swinhoii* ♂) from Formosa, a Common Spoonbill (*Platalea leucorodia*), European, purchased; three Black Swans (*Cygnus atratus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN

HALLEY'S COMET IN 1456.—"This comet cannot exhibit a greater degree of brightness than when it passes the perihelion in the month of June; it may then be observed some days before perihelion; it is visible at perihelion itself, and, when it has passed that point, it continues to approach the earth, and its brightness consequently increases for some days." In these terms Pingré introduces his account of the appearance of Halley's comet in 1456, when, from the vague notices in the European chronicles which were available to him, he fixed the perihelion passage on June 8 at 22h. 10m. Paris mean time. The comet was observed in China on the morning of May 27.

A recent discovery of contemporary documents has led to our being put in possession of a much closer approximation to the elements of the orbit of Halley's comet at this return than it was possible to deduce from the published records of European historians and the Chinese description of its track given by Edouard Biot in the *Connaissance des Temps* for 1846. Prof. Uzielli a few years since found in the National Library at Florence a manuscript of Paolo dal Pozzo Toscanelli, with a chart upon which the positions of the comet and neighbouring stars are shown between June 8 and July 8, of which he forwarded a *fac-simile* to Prof. Celoria of the Royal Observatory at Milan, who has utilised it for the determination of the comet's orbit. There are in all, positions on twenty-four days. Prof. Celoria first compared the places of twenty-one stars read off from the chart, with their places reduced from modern positions to 1456·5, and found a mean correction of + 26′ to Toscanelli's longitudes and + 24′ to his latitudes—a rather surprising agreement for that epoch. Whether Toscanelli obtained his places from the catalogue of the Almagest, from that of Ulug Beigh, or some Arabian catalogue that had reached him, does not appear. The corrections named were applied to Toscanelli's positions of the comet, and, assuming the semi-axis major to have been 17·9676 (this value corresponding to the mean period between 1378 and 1835), Celoria obtains a first set of elements, which are used in the formation of normal places and differential equations, the solution of which leads him to the following most probable elements of the comet's orbit, depending on Toscanelli's observations:—

Perihelion passage 1456, June 8·20875, Paris M.T.

Longitude of perihelion	298° 56′ 47″	Equinox of 1456·5
,, ascending node ...	43 46 4	
Inclination	17 37 27	
Log. excentricity	9·98580	
Log. perihelion distance	9·76363	

Motion—retrograde.

On May 26·266 Paris M.T., about which time the comet was detected in China, the above elements give its position in R.A. 35° 43′, Decl. +23° 53′, distance from the earth 1·140, and from the sun 0·646. On June 17·333, in R.A. 106°·5, Decl. + 40°·7, it was at its least distance from the earth (0·446), and having then passed the perihelion about nine days, it was doubtless near this time that the comet created so much alarm by its brilliancy and magnitude. On July 8 339, when it was last observed by Toscanelli, its position was in R.A. 166° 34′, Decl. + 7°·0′, distance from the earth, 1·051, and from the sun 0·865.

The latest translation of the Chinese description of the track of the comet will be found in Williams's well-known volume, p. 77.

In addition to the observations of Halley's comet, Toscanelli's manuscripts supply observations of the comets of 1433, 1449, 1457 (I. and II.), and 1472, and Prof. Celoria has published elements deduced therefrom of all, except that of 1472, in the *Astronomische Nachrichten.* It appears beyond question, to use Prof. Celoria's own words, "Che le osservazioni in esso contenute sono assai preziose, danno a Toscanelli il vanto di avere prima d'ogni altro fatte intorno alle comete osservazioni propriamente dette, e rivelano in lui un osservatore abile non che una conoscenza sicura ed intera del cielo."

Irving represents Toscanelli as the correspondent and adviser of Columbus. Montucla's account of him chiefly relates to his erection of the gnomon in the Church of S. Maria del Fiore, at Florence, of which Ximenes published an account in 1757, wherein Montucla thought he claimed for Toscanelli more than was his due. As, however, Prof. Uzielli is engaged on researches respecting him, we may soon be more fully informed as to the works of one who certainly claims an honourable place in the history of observational astronomy.

THE TOTAL SOLAR ECLIPSE ON SEPTEMBER 9. It may be remembered that during totality in the eclipse of December 22, 1870, the planet Saturn was situate within the coronal limits, but we are not sure that it was anywhere distinctly remarked. At the time of totality in the eclipse of September next in New

Zealand the planet Jupiter will be similarly situated. Thus at the middle of the eclipse at Castle Point, on the south-east coast of the North Island, the distance of Jupiter from the moon's limb will be 45′, and the angle of position from her centre about 26°.

There appears to be every probability that an expedition from the Australian observatories will take part in the observation of the eclipse on the shores of Cook's Straits, or in the vicinity of Castle Point.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, *APRIL* 26 *TO MAY* 2

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on April 26

Sun rises, 4h. 44m.; souths, 11h. 57m. 39·4s.; sets, 19h. 13m.; decl. on meridian, 13° 39′ N.: Sidereal Time at Sunset, 9h. 33m.

Moon (Full on April 29) rises, 16h. 16m.; souths, 22h. 14m.; sets, 4h. 1m.*; decl. on meridian, 3° 15′ S.

Planet	Rises	Souths	Sets	Decl. on meridian
	h. m.	h. m.	h. m.	° ′
Mercury	4 39	12 6	19 33	15 45 N.
Venus	4 45	11 51	18 57	12 0 N.
Mars	4 18	10 59	17 40	7 26 N.
Jupiter	12 17	19 34	2 51*	14 1 N.
Saturn	6 56	15 3	23 10	22 7 N.

* Indicates that the setting is that of the following day.

Occultations of Stars by the Moon

April	Star	Mag.	Disap.	Reap.	Corresponding angles from vertex to right for inverted image
			h. m.	h. m.	° °
26	B.A.C. 4255	6½	20 28	21 39	66 219
30	o′ Libræ	6	3 46	4 55	92 310
May					
2	29 Ophiuchi	6	3 14	4 22	62 321

Phenomena of Jupiter's Satellites

April	h. m.		May	h. m.	
26	20 59	II. ecl. reap.	1	23 5	II. tr. ing.
27	20 35	IV. ecl. reap.	2	2 1	II. tr. egr.
28	0 11	I. occ. disap.		20 3	III. tr. ing.
	21 31	I. tr. ing.		23 43	III. tr. egr.
	23 51	I. tr. egr.			
29	22 8	I. ecl. reap.			

The Occultations of Stars and Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

April	h.	
28	3	Mercury in inferior conjunction with the Sun.
28	19	Mercury in conjunction with and 1° 42′ north of Venus.

GEOGRAPHICAL NOTES

The Arctic steamer *Alert*, which is about to be returned by the Government of the United States to that of Great Britain, has been lent by the latter to Canada for the continuance of the Hudson's Bay Survey, for which purpose thirty thousand dollars will be asked from the Dominion Parliament.

At the last meeting of the Geographical Society of Munich Dr. Clauss described his journey in South America, exploring the water-shed between the Paraguay and the Amazon. His companions were the brothers Von den Steinen. Thay ascended the Paraguay by steamer, and after eighteen days' journey reached Cuyaba, the capital of the Brazilian province of Matto Grosso, and the terminus of the steamship line on the river. Here they got a military escort and provisions. After remaining eight weeks in Cuyaba they started, with three months' provisions and an escort of fifteen men, to cross the water shed to the Amazon. This elevation, which is only 300 to 400 metres in height, presents the appearance of a savannah, broken up by forests, which follow the watercourses. The formation is sandstone, covered with a reddish clay, containing lumps of ironore. The nights on this plateau were very cold. The watersheds between the various tributaries of the Amazon here were unknown. Brazilian geographers direct the whole upper course of the Xingu to the Tapajos, and put the source of the former under 11° south latitude. After the expedition had crossed the last tributary of the Tapajos, they reached, after eight days' journey, to the east, a large river. Here the oxen which remained healthy were killed, canoes were made from the bark of the Yatoba tree, and, after they had learnt that no larger river existed farther east, they began their voyage on the river, which, in honour of the governor of the province, was called Rio Batovy. The course is interrupted by numerous falls and rapids. In passing these obstacles the boats frequently capsized, and many valuable portions of the collections were lost. After a long and difficult voyage the party reached some Bacairi villages, the inhabitants of which were found wholly ignorant of metals. Through the Rio Batovy they reached a large river, undoubtedly the Xingu. Here they had a collision, which ended satisfactorily, with the Trumai Indians; subsequently they came in friendly contact with the Suya, from whom they received much important information about the hydrography of the region. At 9° south latitude waterfalls were again reached, which rendered navigation difficult, although the river was here a kilometre in width. When their provisions were almost wholly exhausted they reached the settlements of the Yuruna Indians, who understood Portuguese, and received further supplies from them. From 8° to 3° S. the Xingu falls 200 metres in a series of cataracts. Under the guidance of the Yurunas these rapids were passed, and on October 15 the first Portuguese settlement was reached, and the travellers took steamer on the Amazon to Para, which they reached after five months spent in the most unknown regions of Brazil.

The Vienna correspondent of the *Times* states that an extraordinary meeting of the Geographical Society of Vienna will shortly be held to welcome the Austrian African explorers, Dr. Paulitschke and Dr. von Hardegger. The Crown Prince of Austria will be present. The travellers started from Trieste on December 30, 1884, and chiefly explored the interior of the Gallas country. At Harrar, the largest town of East Africa, they were amicably received by the Egyptian governor, Abdallah, son of the Emir Mahomed Abdel Shakur, murdered in 1875. The Governor was just engaged in forming an army. On their return, on March 25, they found Zeila half in ruins. The Austrian explorers have established meteorological stations at Harrar and Zeila, which will be looked after by the English Consuls, Pitten and King. The collections they have brought with them, filling several cases, will constitute a very valuable addition to the Austrian Imperial Museum. The travellers will, in a few days, report personally to the Crown Prince, and submit a comprehensive statement of the commercial conditions of East Africa to the Minister of Commerce.

A Parliamentary paper (Corea, No. 2, 1885) issued during the past week contains a report by Mr. Carles, of the British Consulate at Seoul, of a journey made by him at the close of last year through Northern Corea. The journey lasted about six weeks, and appears to have extended over about 3000 *li*. Starting from Seoul, Mr. Carles went along the western coast road through Kaisong, Hwang-ju, Phyong Yang and An-ju to Wy-ju, where the river forming the boundary between China and Corea was reached. Having ascended the valley of this river several days' journey, he turned towards the east coast through Kang-ge and Ham-heung, to the treaty port of Gensan on the Sea of Japan, from whence it is about a week's journey back to the capital. Among the points noticeable in this excellent report, extending to thirty-two octavo pages, we observe that in Corea, as in a lesser degree in Japan, there is a great disproportion between the number of males and females, the former being more numerous. In the large towns this is ascribed to the immense staffs attached to the officials, but in the villages there is no corresponding balance in favour of females, and it is probable that an explanation which accounts for the disproportion by a greater number of deaths among girls in infancy is correct, for there was no evidence of female infanticide. Corea has been said to be a land of large hats, but this does not tell everything. One would hardly expect the following dimensions from this statement alone. At Phyong Yang, a large and historical town near the west coast, Mr. Carles records that the hats worn by the poor women are baskets 3½ feet long, 2½ feet wide, and 2½ feet deep, which conceal their faces as effectually as the white cloak worn by women of a better class over their heads. The men wear a basket of the same shape, but somewhat smaller. It, however, requires the use of both hands to keep it in place. A structure of a size but little larger, which is used to cover fishing-boats, suggests to the traveller that the women's hats

should be converted into coracles. Literature is honoured in Corea as in other Eastern countries, but the monument erected over the graves of the doctors of letters are at least unique. It consists of the trunk of a tree painted like a barber's pole, some 30 feet up. The top and branches are cut off, and on the summit rests a carved figure of slim proportions, 20 feet long, and with a forked tail in imitation of a Corean dragon. From the head, which resembles that of an alligator, depends cords on which brass bells and a wooden fish are strung. The total absence in even the most ancient and historical provincial towns of any remains of art and culture, leads Mr. Carles to think that perhaps the Corea of olden days differed but little from that of the present time, and that her early civilisation has been greatly overrated. Frequent evidences of mineral wealth were observed. The contradictory reports on this subject are very perplexing. Not long since we published a statement from a traveller in Corea that there were few or no traces of mineral deposits, while the general impression has been that the country was very wealthy in gold, iron, and coal. Nothing but a special survey will set the question at rest. No map or sketch accompanies this report. Unfortunately maps of Corea are rare. An excellent one was published not long since in *Petermann's Mittheilungen*. It is compiled, with Mr. Satow's assistance, and under his supervision, from the maps of the Japanese general staff. A slight sketch-map of Corea would have rendered Mr. Carles's interesting report much more intelligible than it is at present.

THE last *Bulletin* of the American Geographical Society contains an account of the reception of Lieut. Greeley by the members of the Society, and a paper by Lieut. Schwatka describing his exploration on the Yukon River in 1883. A marvellous account is given of the ravages of the mosquito pest in Alaska during the warm months. Shooting on one occasion was out of the question, not altogether on account of the venomous attacks of these insects, but because they were so thick and dense that no one could have seen clearly through the mass in taking aim. Native dogs are killed by them under certain circumstances, and Lieut. Schwatka heard reports from persons so reliable that, coupled with his own experience, he never doubted them, that the great grizzly bear of these regions is at times compelled to succumb. "The statement seems preposterous, but the explanation is simple: the bear, in trespassing on a swampy habitation of mosquitoes, instead of seeking safety in flight, rears upon his hind-quarters and fights them bear-fashion until his eyes are closed by their repeated attacks on them, when starvation is the real cause of death."

THE German Foreign Office has made a communication to the Berlin Geographical Society on the changes in the political geography of South America (which were, the statement says, not inconsiderable) produced by the late war between Bolivia, Peru, and Chili. (1) By the treaty of Ancon of October 20, 1883, Peru ceded to Chili, "permanently and unconditionally," the coast province of Tarapaca, the boundaries of which were declared to be "in the north the defile and River Camarones, in the south the defile and River Loa." This new Chilian province is, by a law of October 10, 1884, divided into two departments, Pisagua and Tarapaca. The latter, chief town Iquique, has for boundaries "towards the territory of Antofagasta the River Loa to Quillagua, and a line from the latter across the volcanoes Miño and Olca to the volcano Tua." The boundary between the two departments is formed by the Quebrada des Aroma to Curana, and from there to a point on the coast two kilometres from Caleta Buena. This change in the dominion of the respective States is regarded as final. But the two following appear to be regarded as provisional only. (2) Bolivia agreed, in the armistice convention concluded at Valparaiso on April 4, 1884, and ratified on November 20 last, that Chili shall hold provisionally (that is, during the armistice, the length of which is not defined) the coast of Bolivia from the 23rd degree south latitude to the mouth of the Loa River, and eastward to the boundary line "from Sapalega to the volcano Licancaur, from there to the volcano Cavana, thence to the southern watercourse of Lake Ascotan, Mount Allagu, and the borders of Tarapaca." This portion of Bolivia corresponds to the Bolivian province of Atacama, and had not been organised by Chili at the commencement of the present year. (3) Peru, by Article 3 of the Treaty of Ancon, has ceded to Chili until March 28, 1894, the provinces of Tacna and Arica. This territory "is ounded on the north by the Sama River from its source in the chain of mountains on the frontiers of Bolivia, to its mouth, and on the south by the defile and River Camarones." By a Chilian law of October 31, 1884, these form a single province with the departments Tacna and Arica.

BEFORE the Royal Colonial Institute, on April 14, Mr. Justice Pinsent, of Newfoundland, read a most interesting paper on this oldest of British colonies. From a geographical point of view, the earlier and more antiquarian portion of the paper is the most interesting. The writer describes the discoveries of Sebastian Cabot and the early history of Newfoundland, a name which was originally given to the continent and islands *en masse*, and which, when divers parts were given different names, came to be applied only to that island which still bears the name, and which long lent to those discoveries their chief importance.

AT the meeting of the Paris Geographical Society, on the 10th inst., M. Venukoff communicated a letter which he received from the Russian General Stebintsky, reporting that Capt. Guedenoff had completed a journey in the Trans-Caspian regions with the object of determining the positions of various points in the basin of the Amu-Darya. He commenced at Kizil-Arvat, whence he went to Igdy, and then towards Petro-Alexandrovsk by Khiva. He ascended the Oxus to Charjni, and then returned through Southern Turkomania by Merv and Askabad. He travelled 1200 kilometres, and determined forty-eight points.—A letter was read which General Faidherbe had addressed to the Italian Geographical Society on the subject of doubts expressed in its *Bulletin* on the authenticity of the story of a journey by M. Buonfanti to the Soudan and Timbuctoo. The General reports a conversation which he held on the subject with the "envoy" of Timbuctoo recently in Paris. The envoy had not seen this traveller in Timbuctoo, but recollected hearing of his having been there.—M. de Rivoyre described the Bay of Adulis in the Red Sea, which now belongs to France. The possession of this place and of Obock, he said, gave France a position from which she could watch calmly the events now proceeding in Ethiopia.—M. Germain Bapst described his explorations in Armenia, on the frontiers of the three empires of Turkey, Russia, and Persia, and gave some interesting information on the semi-barbarous populations living in these regions.

THE last number (Bd. xix. Heft 6) of the *Zeitschrift der Gesellschaft für Erdkunde zu Berlin* contains a translation of the Report on the Russian National Survey for 1883, and the usual tabulated catalogue of books, articles, maps, and plans, published between November, 1883, and 1884, in the domain of geography.

THE SCOTTISH METEOROLOGICAL SOCIETY

AT the annual meeting on March 23, Dr. Arthur Mitchell, F.R.S.E., in the chair, it was stated in the Report of the Council that since last meeting in July two new stations had been established—one at Lednathie, Kirriemuir, and the other at Comrie, Perthshire. During the summer and autumn the Secretary inspected twenty-six stations. In addition to the ordinary work of the office he had prepared a third paper on the climate of the British Islands, embracing the rainfall, which would appear in next issue of the *Journal*. As regards the Ben Nevis Observatory, the observations during the winter had been carried on by Mr. Omond and his assistants every hour by night and by day, without the break of a single hour, except during a great storm which raged around the Observatory in February, when from 6 p.m. of the 21st to 7 a.m. of the following day such was the violence of the wind, that for those fourteen hours no light could be carried outside by which the thermometers could be read. The directors had given permission for the erection of a seismometer for registering earth-movements at the Observatory, a grant of 200*l.* for its erection having been obtained by Mr. George Darwin and Prof. Ewing from the Government Grant Committee. The total cost of the erection and maintenance of the Observatory up to January 31, 1885, was 5935*l.*, which was 325 in excess of the subscriptions and other moneys received. The actual cost above what was originally estimated amounted to upwards of 1600*l.* This excess arose chiefly from the additions it was found necessary to make to the buildings, the extra furnishings required for the new portion, the great cost of making and maintaining the road, and of the transport to the top of building materials and stores. It was hoped that the public, to whose liberality this great national observatory owed its existence, would by additional subscriptions

enable the directors to place the Observatory in efficient working order. The work at the Scottish Marine Station continues to be prosecuted with energy and success. The Council had recommended that the grant from the Fishery Fund of the Society for the year ending November next be increased from 250*l.* to 300*l.* In November, 1884, an application on the part of the Tweed Salmon Commissioners was made to the Council for advice and assistance in investigations which the Commissioners had resolved to undertake into the salmon disease, and questions generally affecting the salmon fisheries; and the Commissioners were now carrying out a scheme of observations recommended by the Council.

Mr. John Murray read a report on the Scottish Marine Station, stating that there is every reason to be satisfied with the support which the Station is receiving and with the work done. A sum of 1456*l.* 13*s.* 1*d.* has up to the present time been received in subscriptions from the general public, to which is to be added the donation of 1000*l.* which led directly to the foundation of the Station. The Scottish Meteorological Society has promised an annual contribution of 300*l.* for three years, and for the present year the British Association has voted a grant of 100*l.* The Royal Society of London and the Government Grant Committee have sanctioned grants to the amount of 520*l.* to assist scientific men who will carry on their researches chiefly by means of the appliances and conveniences offered by the Station. The total expenditure up to the present time for the equipment and maintenance of the Station amounts to 2751*l.* 8*s.* 1*d.* The completion of the additions now in progress, and the maintenance of the station till November 1, 1885, will cost a further sum of 900*l.* At the request of a number of naturalists it is proposed to establish a temporary laboratory at Millport, on the Clyde, with sufficient accommodation for six workers, during the months of July and August of this year. The yacht *Medusa* will be in attendance to carry on dredging or assist in making observations in the estuary of the Clyde or any of the lochs which open into it. It is hoped that a permanent branch of the Station may ultimately be established at Millport.

Mr. H. R. Mill, B.Sc., submitted a detailed report of the meteorological part of the work carried on at the Marine Station, in which it was mentioned that plans of a new chemical laboratory were being prepared. A number of observations had been made to ascertain the temperature and salinity of the water at the bottom and the surface, and to find out the penetrability of light. It was found that a piece of photographic printing paper was completely blackened by exposing it to 109 hours of daylight at a depth of 30 feet, while at fifteen feet it was blackened by 42 hours exposure. As to the temperature, the general law seemed to be that the range between summer and winter was nearly four times as great at Alloa and twice as great at Queensferry as it was at the Isle of May; and that in summer the temperature of the water fell steadily from Alloa to the May, and in winter rose with equal uniformity. The variations in salinity were very slight from Inchkeith to the mouth of the Forth, while from Inchgarvie to Alloa they were very great both between high and low tide, bottom and surface, at the same place and between differences on the Forth short distances apart.

A paper on anemometrical observations at Dundee was read by Mr. Cunningham, C.E., showing the diurnal velocity of the wind during the seasons and during cyclones and anticyclones. The daily maximum velocity occurred a little after 2 p.m., and the minimum from midnight to 6 a.m. During anticyclones the velocity of the wind was less during the night in summer than during winter, but stronger during the day. Mr. Cunningham also showed an elaborate diagram he had prepared for facilitating hygrometric calculations. A paper by Mr. Omond was read, on the formation of snow-crystals from fog on Ben Nevis (NATURE, vol. xxxi. p. 532), and a paper by Mr. Buchan, on the meteorology of Ben Nevis to February, 1884.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The Report of the Examiners at the last Cambridge Local Examinations speaks very favourably of the Euclid and Algebra papers. Trigonometry and Mechanics were done badly at some centres, but very well at others; the seniors did well in Statics, but the majority of candidates answered poorly in Astronomy.

In Practical Chemistry a larger proportion of juniors than last year gained high marks, and the percentage of failures was considerably less than in the theoretical paper. A few seniors sent in very good answers, but the greater number wrote answers to which it was difficult to attach a definite meaning. The phenomena and principles of Chemistry were evidently quite unreal to most of the senior candidates.

In Heat the juniors did rather worse than last year; bookwork was fairly done, but the simpler laws and principles were often converted into utter nonsense. The seniors as a whole answered badly; many were quite unfamiliar with most elementary facts and every-day occurrences, and had no notion of scientific methods or accurate reasoning.

In Statics, Hydrostatics, &c., the work was moderately well done; but the questions on Dynamics and Friction were very unsatisfactorily answered by the seniors.

Electricity and Magnetism showed a slight improvement.

Biology showed a large percentage of failures, owing to inadequate practical study.

Botany was ill done by most juniors; inaccurate descriptions and incorrect use of terminology were prominent. Many seniors showed fair knowledge of at least some part of the subject. Morphology and Classification of Flowering Plants, with descriptions of specimens, were the weakest parts of the examination.

In Zoology many of the junior candidates were quite unfit to enter for the examination; antiquated text-books and inefficient teaching were answerable for this. The seniors did slightly better, but had little practical knowledge of animals.

In Physical Geography all but a few did inferior papers, having learnt some facts and reasons by rote, without attempting to understand them. There was, in most cases, complete ignorance of the meaning of sections and contour lines.

UNIVERSITY OF NEW ZEALAND.—The annual meeting of the Senate of this University was recently held at Auckland, and extended over several days at the end of February and beginning of March. In consequence of the death of the Chancellor, Mr. Henry John Tancred, who had held office for twelve years, the Vice-Chancellor, Dr. James Hector, F.R.S., C.M.G., &c., was elected to the Chancellorship, and Rev. J. C. Andrew was chosen Vice-Chancellor. Dr. Hector, as Chancellor-Elect, announced, on the authority of Sir Julius Vogel, that the Government contemplated the establishment of four scholarships for the promotion of scientific and technical education, the management and administration of which were to be intrusted to the University. They would be tenable for eight years, and would be open to pupils from any school in the colony, or to competitors at any industrial exhibition, subject to an examination equal to the fourth standard of primary schools. Holders of these scholarships would spend the first four years at a secondary school, the next three in a University course, in preparation for a science degree, and the last year in preparation for taking honours in science.

The report of the Vice-Chancellor dealt mainly with local matters, but referred to the attendance of an ex-Vice-Chancellor as a representative of the University at the tercentenary celebration of the University of Edinburgh, and to the election by the Senate of new examiners during the previous year. It may not be generally known to English readers that all the degree examinations of this University are conducted entirely by papers set and printed in England, and that the answers are revised by the English examiners, who in all cases either are, or have been, examiners for the Universities of London, Cambridge, or Oxford. The standard maintained is, as nearly as possible, that of the University of London. More than eighty candidates presented themselves at the degree examinations last November from a population not exceeding half a million. The agent for the University in England is Mr. Wm. Lant Carpenter, B.A., B.Sc., of Harlesden, London, N.W.

SCIENTIFIC SERIALS

Journal of the Franklin Institute, No. 711, March, 1885.—E. A. Gieseler, on tidal theory and tidal predictions.—Prof. E. J. Houston, glimpses of the International Electrical Exhibition, No. VI. McDonough's telephonic inventions. This gives an interesting account of the instruments invented by McDonough between the years 1867 and 1876, the receiver of which anticipated in all its main features the form of receiver introduced by Graham Bell.—Prof. C. A. Young, physical constitution of the sun; a lecture delivered at the Electrical Exhibition, illustrated

with many cuts.—C. E. Fritts, on the Fritts selenium cells and batteries. These cells, in which the light enters through a film of gold-leaf appear to have a much lower resistance than any other selenium cell.—Prof. E. J. Houston, on Delaney's facsimile telegraphic transmission. This number of the journal is also accompanied by reports of the Examiners of certain Sections of the late Philadelphia Exhibition, including electric telegraphs, dental appliances, and applications of electricity to warfare.

Bulletin de l'Académie Royale de Belgique, February 7.—Experimental and analytical researches on the action and concussion of gases at various temperatures, by M. Hirn.—A study of the physical aspect of the planet Jupiter, by F. Terby.—Researches on the spectrum of carbon in the electric arc in connection with the spectra of the comets and the sun, by Ch. Fievez.—Remarks on the application of electricity to aerial navigation, by MM. Gérard, Van Weddingen and Jacquet.—On the agreement between atmospheric variations and the indications of colours in stellar scintillations, by Ch. Montigny.—On the presence of chiastolite rocks in the Lower Devonian formation of the Belgian Ardennes, by E. Dupont.—A new formula applicable to the development of functions, and especially of integers, by Ch. Lagrange.—Remarks on Massy's Glossary of the Egyptian novel of Setna, by M. Wagener.—The death of Don Juan of Austria, by Baron Kervyn de Lettenhove.

Engler's Botanische Jahrbücher, Sechster Band (1885), Heft 1.—Œmilius Kœhne, Lythraceæ, der Bau der Blüthen. Though the majority of the plants of this order are clearly entomophilous, the author is compelled to regard certain species as cleistogamic, *e.g.* species of *Ammannia* and *Rotala*.—A. Engler, Beiträge zur Flora des südlichen Japan und der Liu-kiu-Inseln.—J. C. Maximowicz, *Amaryllidaceæ sinico-japonicæ*.—A. G. Nathorst, Notizen über die Phanerogamenflora Grönlands im Norden von Melville Bay.—Litteraturbericht.

Heft 2.—T. F. Cheeseman, Die naturalisirten Pflanzen des Provincial-Districts Auckland. The author is inclined to conclude that the struggle between the naturalised and the indigenous flora will result in a limitation of the distribution of the indigenous species, rather than in their actual extinction. It must be confessed, however, that some few indigenous species appear to have already become extinct.—A. Peter, Ueber spontane und künstliche Gartenbastarde der Gattung *Hieracium*, sect. *Pilosell-oidea*.—F. Hildebrand, Ueber *Heteranthera zosterifolia*. The plant develops differently according as it grows in shallower or in deeper water; in the latter case float-leaves are formed, which differ widely in form from the ordinary leaves of the plant (one plate).—Lad. Celakovský, Linné's Antheil an der Lehre von der Metamorphose der Pflanze. The author concludes, from careful study of the writings of Linnæus and his pupils, that Linnæus definitely laid down the fundamental principle of metamorphosis before Wolff and Goethe.—Litteraturbericht.

Heft 3.—Franz Buchenau, Die Juncaceen aus Indien (plates 2 and 3).—E. Hackel, Die auf der Expedition S.M.S. *Gazelle* von Dr. Naumann gesammelten Gramineen.—H. Dingler, Der Aufbau des Weinstockes (plate 4).—A. Engler, Beiträge zur Kenntniss der Araceæ, vi.—A. Engler, Eine neue Schinopsis.—Beiblatt, short notice of Apospory, and of Treub's discoveries on the sexual reproduction of *Lycopodium*.—Litteraturbericht.

Journal de Physique, March.—Prof. Mascart, on the employment of the method, of damping for determining the value of the ohm.—L. Bleekrode, experimental researches on the refraction of liquefied gases. These are determined by the method of De Chaulnes.—L. Cailletet, new apparatus for preparing solid carbonic acid.—M. Vaschy, note on the theory of telephonic apparatus.—G. Meslin, on the definition of perfect gases, and on the resulting properties. The author objects to the usual statement of the combined laws, because it rests upon the definition of temperature, which again rests upon the properties of perfect gases. He proposes to deduce all gaseous laws from the following definitions:—"A perfect gas is one which perfectly obeys the law of Mariotte at all temperatures, and for which there is no change in the (true) specific heat when the volume changes."—R. T. Glazebrook, on a method of measuring the electrical capacity of a condenser (abstract from *Phil. Mag.*).—C. R. Alder-Wright and C. Thompson, on the variation of chemical affinity in terms of electromotive force (from *Phil. Mag.*).—W. Hankel, on the electricity developed during certain processes evolving gases.—P. Kramer, Descartes and the law of refraction of light. A polemic to show that the accusation made against Descartes of having appropriated the discovery of Snell is unfounded.—A. Genocchi, on some writings concerning the deviations of the pendulum and the experiment of Foucault.

Rivista Scientifico-Industriale, March 15.—Some experiments made by Prof. Tito Martini with an accumulator of the Planté type modified by Antonio Trevisan.—Influence of the capacity of the condensor on electric sparks, and their duration in connection with the hypothesis which considers electricity as an incompressible fluid, by Dr. Pietro Cardani.—Remarks on the Trouvé universal incandescent electric lamps (continued; two illustrations), by the Editor.—Experimental researches on the action of boric acid in the human system in connection with epidemics and contagious diseases, by Prof. Philippo Artimini.—On a method for extracting chlorophyll, by E. Guignet.—On certain so-called "thunderbolts" of volcanic origin recently found on Mount St. Angelo, near Baccano, and in some other places east of Lake Bracciano, by Prof. G. Strüver.

SOCIETIES AND ACADEMIES

London

Royal Society, April 16.—"On the Agency of Water in Volcanic Eruptions, with some Observations on the Thickness of the Earth's Crust from a Geological Point of View, and on the Primary Cause of Volcanic Action." By Joseph Prestwich, F.R.S., Professor of Geology in the University of Oxford.

That water plays an important part in volcanic eruptions is a well-established fact, but there is a difference of opinion as to whether it should be regarded as a primary or a secondary agent, and as to the time, place, and mode of its intervention. The author gives the opinions of Daubeny, Poulett Scrope, and Mallet, and, dismissing the first and last as not meeting the views of geologists proceeds to examine the grounds of Scrope's hypothesis—the one generally accepted in this country—which holds that the rise of lava in a volcanic vent is occasioned by the expansion of volumes of high pressure steam generated in the interior of a mass of liquefied and heated mineral matter within or beneath the eruptive orifice, or that volcanic eruptions are to be attributed to the escape of high pressure steam existing in the interior of the earth. The way in which the water is introduced and where is not explained, but as the expulsion of the lava is considered to be due to the force of the imprisoned vapour, it is, of course, necessary that it should extend to the very base of the volcanic foci, just as it is necessary that the powder must be in the breech of the gun to effect the expulsion of the ball.

The author then proceeds to state his objections to this hypothesis. In the first place he questions whether it is possible for water to penetrate to a heated or molten magma underlying the solid crust. The stratigraphical difficulties are not insurmountable, although it is well known that the quantity of water within the depths actually reached in mines decreases, as a rule, with the depth, and is less in the Palæozoic than in the Mesozoic and Kainozoic strata.

The main difficulty is thermo-dynamical. As the elastic vapour of water increases with the rise of temperature, and faster at high than at low temperatures, the pressure—which at a depth of about 7500 feet and with a temperature (taking the thermometric gradient at 48 feet per 1° F.) of 212° F., would be equal to that of one atmosphere only—would at a depth of 15,000 feet and a temperature of 362°, be equal to 10½ atmospheres, and at 20,000 feet and temperature of 467° would exceed 25 atmospheres. Beyond this temperature the pressure has only been determined by empirical formulæ, which, as the increase of pressure is nearly proportional to the fifth power of the excess of temperature, would show that the pressure, in presence of the heat at greater depths, becomes excessive. Thus, if the formulæ hold good to the critical point of water, or 773°, there would at that temperature be a pressure of about 350 atmospheres.

At temperatures exceeding 1000° F. and depth of about 50,000 feet, the experiments of M. H. St. Claire Deville have shown that the vapour of water, under certain conditions, probably undergoes disassociation, and, consequently, a large increase in volume. It would follow also on this that if the water-vapour had been subject to the long-continued action of the high temperatures of great depths, we might expect to meet with a less amount of steam and a larger proportion of its constituent gases than occurs in the eruptions. Capillarity will assist the descent, and pressure will cause the water to retain its fluidity to con-

siderable depths, but with the increasing heat capillarity loses its power.

Taking these various conditions into consideration, the author doubts whether the surface-waters can penetrate to depths of more than seven to eight miles, and feels it impossible to accept any hypothesis based upon an assumed percolation to unlimited depths. That there should be open fissures through which water could penetrate to the volcanic foci, he also considers an impossibility.

But the objection to which the author attaches most weight against the extravasation of the lava being due to the presence of vapour in the volcanic foci, is, that if such were the case, there should be a distinct relation between the discharge of the lava and of the vapour, whereas the result of an examination of a number of well-recorded eruptions shows that the two operations are in no relation and are perfectly independent. Sometimes there has been a large discharge of lava and little or no escape of steam, and at other times there have been paroxysmal explosive eruptions with little discharge of lava.

There are instances in which the lava of Vesuvius has welled out almost with the tranquility of a water-spring. A great eruption of Etna commenced with violent explosions and ejection of scoriæ, which, after sixteen days, ceased, but the flow of lava continued for four months without further explosions. In the eruption of Santorin, 1866, the rock-emission proceeded for days in silence, the protruded mass of lava forming a hill nearly 500 feet long by 200 feet high, which a witness compared with the steady and uninterrupted growth of a soap-bubble. The eruptions of Mauna Loa are remarkable for their magnitude, and at the same time for their quiet. Speaking of the eruptions of 1855, Dana says there was no earthquake, no internal thunderings, and no premonitions. A vent or fissure was formed, from which a vast body of liquid lava flowed rapidly but quietly, and without steam explosions, for the space of many months.

On the other hand, paroxysmal eruptions are generally accompanied by earthquakes, and begin with one powerful burst, followed rapidly by a succession of explosions, and commonly with little extrusion of lava, although it is to be observed that a large quantity must be blown into scoriæ and lost in the ejections. Such was the eruption of Coseguina in 1835, and of Krakatoa in 1883. Sometimes in these paroxysmal eruptions there is absolutely no escape of lava, scoriæ alone being projected. A common feature in eruptions, and which indicates the termination of the crisis, is the stopping of the lava, though the gaseous explosions continue for some time with scarcely diminished energy.

There is thus no definite relation between the quantity of explosive gases and vapours and the quantity of lava. If the eruption of lava depended on the occluded vapour, it is not easy to see how there could be great flows without a large escape of vapour, or large volumes of vapour without lava. The extrusion of lava has been compared to the boiling over of a viscid substance in a vessel, but the cases are not analogous.

The only logical way in which it would seem possible for water to be present is on the hypothesis of Sterry Hunt who supposes the molten magma to be a re-melted mass of the earlier sedimentary strata, which had been originally subject to surface and meteoric action. But in the end the preceding objections apply equally to this view.

There is the further general objection to the presence of water in the molten magma, in that were the extrusion of lava due to this cause, the extrusion of granite and other molten rocks (which do not, as a rule, lie so deep as the lava magma) should have been the first to feel its influence and to show its presence. Yet although water is present, it is in such small quantities that these rocks never exhibit the scoriaceous character which lava so commonly possesses.

Nor is lava always scoriaceous, as it should be if the hypothesis were correct. Many lavas are perfectly compact and free from vapour-cavities, and so also are especially most of the great sheets of lava (basalt) which welled out through fissures in late geological times. These vast fissure eruptions, which in India and America cover thousands of square miles, and are several thousand feet thick, seem conclusive against water agency, for they have welled out evidently in a state of great fluidity, with extremely little explosive accompaniments, and often without a trace of scoriæ mounds. The general presence of non-hydrated rocks and minerals is also incompatible with the permeation of water which the assumption involves.

It has been suggested by some writers that large subterranean cavities may exist at depths in which the vapour of water is stored under high pressure, but the author shows that such natural cavities are highly improbable in any rocks, and impossible in calcareous strata.

The author proceeds to account for the presence of the enormous quantity of the vapour of water, so constantly present in eruptions, and which, in one eruption of Etna, was estimated by Fouqué to be equal to about 5,000,000 gallons in the twenty-four hours. He refers it to the surface-waters gaining access *during the eruptions* to the volcanic ducts either in the volcanic mountain itself, or at comparatively moderate depths beneath. He describes how the springs and wells are influenced by volcanic outbursts. By some observers, these effects have been referred to the influence of dry and wet seasons, but there are so many recorded instances by competent witnesses, as to leave little doubt of the fact. This was also the decision of the inquiry by the late Prof. Phillips, who asks, Why is the drying up of the wells and springs an indication of coming disaster?

The author then considers the hydro-geological condition of the underground waters. He points to the well-known fact, that on the surface of volcanoes the whole of the rainfall disappears at once, and shows that when the mountain is at rest, the underground water must behave as in ordinary sedimentary strata. Therefore, the water will remain stored in the body of the mountain, in the interstices of the rocks and scoriæ, and in the many empty lava-tunnels and cavities. The level of this water will rise with the height of the mountain, and he estimates that it has at times reached in Etna a height of 5000 to 6000 feet, while the permanent level of the springs at the base of the mountain seems to be at about 2000 feet. The water does not, however, form one common reservoir, but is divided into a number of independent levels by the irregular distribution of the scoriæ, lava, &c. These beds are traversed by vertical dykes running radially from the crater, so that, as they generally admit of the passage of water, the dykes serve as conduits to carry the water to the central duct.

Little is known of the sedimentary strata on which volcanoes stand. In Naples, however, an artesian well found them under the volcanic materials in usual succession, and with several water-bearing beds, from one of which, at a depth of 1524 feet, a spring of water rose to the surface with a discharge of 440 gallons per minute. When in a state of rest the surplus underground waters escape in the ordinary way by springs on the surface, or when the strata crop out in the sea, they then form submarine springs.

During an eruption these conditions are completely changed. The ascending lava, as it crashes through the solid plug formed during a lengthened period of repose, comes in contact with the water lodged around or, may be, in the duct, which is at once flashed into steam, and gives rise to explosions more or less violent. These explosions rend the mountain, and fresh fissures are formed which further serve to carry the water to the duct from which they proceed; or they may serve as channels for the sea-water to flood the crater, when, as in the case of Coseguina and Krakatoa, the volcano is near the sea-level. As the eruption continues, the water-stores immediately around the duct become exhausted, and then the water lodged in the more distant parts of the mountain rushes in to supply the void, and the explosions are violent and prolonged according to the available volume of water in the volcanic beds. When this store is exhausted, the same process will go on with the underlying water-bearing sedimentary strata traversed by the volcanic duct.

The author gives diagrams showing the position of the water-levels *before*, *during*, and *after* eruption; and describes the manner in which, if the strata surrounding the duct and below the sea-level become exhausted, the efflux of the fresh water which passed out to sea through the permeable beds, when the inland waters stood at their normal height above the sea-level, these same beds will in their turn serve as channels for the sea-water to restore the lowered water-level inland. Thus, the excurrent channels which carried the land waters into the sea-bed, and there formed, as they often do off the coasts of the Mediterranean, powerful fresh-water springs, now serve as channels for an in-current stream of sea-water, which, like the fresh water it replaces, passes into the volcanic duct. This agrees with the fact that fresh-water remains are common in many eruptions, and marine diatomaceous remains in others; also that the products of decomposition of sea-water are so abundant during and at the close of eruptions. With the fall of the water-levels, the

available supply of water becomes exhausted, or the channels of communication impeded, and this continues until, with the ceasing of the extravasation of the lava, the eruption comes to an end.

The author then explains the way in which the water may gain access to the lava in the duct, notwithstanding heat and pressure. This he considers to be dependent upon the difference between the statical and the kinetical pressure of the column of lava on the sides of the duct. In the change from the one state to the other, when the lava begins to flow, and its lateral pressure is lessened, the equilibrium with the surrounding elastic high pressure vapour becomes destroyed, and the vapour forces its way into the ascending lava. As this proceeds, the heated water further from the duct, and held back by the pressure of the vapour, flashes into steam to supply its place. If that water should be lodged in the joints of the surrounding rock, blocks of it will also be blown off, driven into, and ejected with, the ascending lava, as have been the blocks in Somma and of other volcanoes.

It is the double action thus established between the inland- and sea-waters that has probably prolonged the activity of the existing volcanoes settled in ocean centres, or along coast-lines, while the great inland volcanic areas of Auvergne, the Eifel, Central Asia, &c., have become dormant or extinct.

But if water only plays a secondary part in volcanic eruptions, to what is the motive power which causes the extravasation of the lava to be attributed? This involves questions connected with the solidity of the globe far more hypothetical and difficult of proof. The author first takes into consideration the probable thickness of the earth's crust from a geological point of view, and shows, that although the present stability of the earth's surface renders it evident that the hypothesis of a thin crust resting on a fluid nucleus is untenable, it is equally difficult to reconcile certain geological phenomena with a globe solid throughout, or even with a very thick crust. The geological phenomena on which he relies in proof of a crust of small thickness, are :—(1) Its flexibility as exhibited down to the most recent mountain uplifts, and in the elevation of continental areas. (2) The increase of temperature with depth. (3) The volcanic phenomena of the present day, and the outwelling of the vast sheets of trappean rocks during late geological periods.

He considers that the squeezing and doubling up of the strata in mountain-chains—as, for example, the 200 miles of originally horizontal strata in the Alps, crushed into a space of 130 miles (and in some cases the compression is still greater)—can only be accounted for on the assumption of a thin crust resting on a yielding substratum, for the strata have bent as only a free surface-plate could to the deformation caused by lateral pressure. If the globe were solid, or the crust of great thickness, there would have been *crushing* and *fracture*, but not *corrugations*. Looking at the dimensions of these folds, it is evident also that the plate could not be of any great thickness. This in connection with the increase of heat with depth, and the rise of the molten lava through volcanic ducts, which, if too long, would allow the lava to consolidate, leads the author to believe that the outer solid crust may be less even than twenty miles thick.

That the crust does possess great mobility is shown by the fact that since the Glacial period there have been movements of continental upheaval—to at least the extent of 1500 to 1800 feet —that within more recent times they have extended to the height of 300 to 400 feet or more, and they have not yet entirely ceased.

With regard to the suggestion of the late Prof. Hopkins that the lava lies in molten lakes at various depths beneath the surface, the author finds it difficult to conceive their isolation as separate and independent local igneous centres, in presence of the large areas occupied by modern and by recently extinct volcanoes. But the chief objection is, that if such lakes existed they would tend to depletion, and as they could not be replenished from surrounding areas, the surface above would cave in and become depressed, whereas areas of volcanic activity are usually areas of elevation, and the great basaltic outwellings of Colorado and Utah, instead of being accompanied by depression, form tracts raised 5000 to 12,000 feet above the sea-level.

These slow secular upheavals and depressions, this domed elevation of great volcanic areas, the author thinks most compatible with the movement of a thin crust on a slowly yielding viscid body or layer, also of no great thickness, and wrapping round a solid nucleus. The viscid magma is thus compressed between the two solids, and while yielding in places to compression, it, as a consequence of its narrow limits, expands in like proportion in conterminous areas. As an example, he instances the imposing slow movements of elevation which have so long been going on along almost all the land bordering the shores of the Polar Seas, and to the areas of depression which so often further south subtend the upheaved districts.

With respect to the primary cause of these changes and of the extravasation of lava, the author sees no hypothesis which meets all the conditions of the case so well as the old hypothesis of secular refrigeration and contraction of a heated globe with a solid crust—not as originally held, with a fluid nucleus, but with the modifications which he has named, and with a *quasi rigidity* compatible with the conclusions of the eminent physicists who have investigated this part of the problem. Although the loss of terrestrial heat by radiation is now exceedingly small, so also is the contraction needed for the quantity of lava ejected. Cordier long since calculated that, supposing five volcanic eruptions to take place annually, it would require a century to shorten the radius of the earth to the extent of 1 mm., or about $\frac{1}{25}$ inch.

The author therefore concludes that, while the extravasation of the lava is due to the latter cause, the presence of vapour is due alone to the surface and underground waters with which it comes into contact as it rises through the volcanic duct, the violence of the eruption being in exact proportion to the quantity which so gains access.

Geologists' Association, April 9.—A short paper entitled Notes on the Oldhaven pebble-beds at Caterham was read by Mr. T. V. Holmes, F.G.S.. The workmen in the gravel-pits adjoining the Caterham Waterworks recently exposed a large cavity in the pebble-beds, which was visible when the writer and Mr. R. Meldola visited the spot in December last. It was cylindrical in shape, from ten to eleven feet in length, and from five to six in diameter, its axis being nearly vertical. Evidence of the existence of others was noted, and it was stated that similar hollows are by no means rare in these pits. These cavities doubtless owed their origin to the existence of pipes in the chalk beneath, which pipes, from the superior tenacity, here and there, of the upper strata of gravel as compared with the lower, had not been entirely filled up. Examples of similar hollows elsewhere were given. The existence of masses of unmodified "loam with flints" in the midst of the pebbles was also noted, and the writer explained how they might be accounted for without recourse to the hypothesis of glacial agency. —On the Glacial Drifts of Norfolk, by Mr. H. B. Woodward, F.G.S. After describing the general characters of the drifts in Norfolk, Mr. Woodward alluded to the difficulties in identifying the subdivisions in different areas, for the beds are variable and no infallible guides are furnished by lithological characters, fossils, or even by stratigraphical sequence. Looked at in a broad way, two divisions might be made out: (1) the Lower Glacial, including the Cromer Till, Contorted Drift, and the so-called Middle Glacial; and (2) the Upper Glacial, including the chalky boulder clay and cannon-shot gravel. These divisions are borne out in part by the evidence of superposition and by the character of the stones imbedded in the boulder clays, and in part by the evidence that the contortions in the Lower Glacial beds were produced by the agent which formed the chalky boulder clay. Mr. Woodward expressed his opinion that the shells found in the Middle Glacial sands did not belong to the Glacial period, but were derived in part from Pliocene strata north of Norfolk, now either entirely removed or buried up beneath the waters of the North Sea. The shells, which include forms that lived during the period of the coralline and red crags, were supposed by some authorities to have migrated from the Mediterranean area during submergence of the tract in Glacial times and at an interval when the climate was mild. Attention was drawn to the occurrence of boulder clay in the Middle Glacial deposits near Hertford; and it was pointed out that shells derived from the coralline and red crags had been found by Mr. T. F. Jamieson in the drift of Aberdeenshire, indicating that Pliocene deposits had formerly extended as far north as Scotland. Briefly alluding to the method of formation of the glacial drifts, Mr. Woodward passed on to notice the occurrence of Palæolithic implements. The mammalian remains associated with these belonged to the group which characterised the older Thames Valley deposits and were met with also on the Dogger Bank. When these deposits were accumulated, probably the Ouse joined the waters of the Thames and Rhine in the area now covered by the North Sea.

Anthropological Institute, April 14.—Prof. Flower, F.R.S., Vice-President, in the chair.—The election of J. G. Frazer, H. R. H. Gosselin, and J. Browne was announced.—Dr. J. G. Garson read a paper on the inhabitants of Tierra del Fuego. Three tribes inhabit the archipelago of Tierra del Fuego: they are called the Onas, who inhabit the north and east shores, and resemble the Patagonians in being a tall race, chiefly living by hunting, but supplementing their food with shell-fish and other marine animals; the Yahgans, who live on the shores of the Beagle Channel and southern islands, and are a short stunted race, subsisting almost entirely on the products of the sea and birds; the Alaculoofs, who dwell on the western islands and are very similar to the Yaghans. These last two tribes and their characters were chiefly discussed, being better known to us. They lead a very degraded life, wandering about from place to place, possess no houses, but construct shelters out of the branches of trees and build canoes of bark; they wear very little clothing of any kind. In stature they are short, the men averaging about 5 feet 3 inches and the women about 5 feet. In the character of their skull and skeleton they resemble the other wild native tribes of America, but by isolation have assumed certain characters peculiar to themselves. The population of the Fuegian Islands appears to be about 3000. Much information is still required regarding the people and their social customs. The osteological characters of the Yahgans were pointed out and discussed.

EDINBURGH

Mathematical Society, April 10.—Mr. A. J. G. Barclay, President, in the chair.—Mr. T. B. Sprague, F.R.S.E., contributed a paper, which was read by Prof. Chrystal, on the indeterminate form 0°; and Mr. John Alison discussed the properties of the so-called Simson line.

Royal Physical Society, April 15, Prof. John Duns, D.D., F.R.S.E., President, in the chair.—The President read a paper on Abnormalities of Development and the Reproduction of Lost Parts in Living Organisms, with exhibition of *Tiliqua fernandi*, and other specimens.—Mr. H. M. Cadell, B.Sc., H.M. Geological Survey, communicated notes on contorted shales below the Till in Craigleith Quarry. These were very fine examples, and he observed them below the boulder clay on the east side of the quarry in 1880. The non-bituminous shales overlying the sandstone were at some places turned up, and curled over as if by some heavy body, which might either have been the great ice sheet which moved from west to east across the country during the glacial period, or icebergs sailing along at a later part of the same period, and striking the bottom with projecting corners. The fact that the shales were twisted in different directions seemed to favour the iceberg theory in this instance. Mr. Cadell also referred to contortions of the edges of the same series of shales in the Suburban Railway cutting at Meggetland and near Craiglockhart Hill. Bending over of the edges of slates, &c., was sometimes seen in cases where the strata dipped at high angles into the face of a slope, and this might lead an inexperienced geologist into great perplexity. This kind of bending was due simply to gravitation, and had nothing to do with ice action. Mr. F. E. Beddard, M.A., F.R.S.E., F.Z.S., communicated a note on the anatomy of a new species of earthworm, belonging to the genus *Acanthodrilus*.—Mr. W. Ivison Macadam, F.C.S., referred to the presence of *Fragillaria* in enlarged quantities in the water supply of Elie, in Fife. The idatom was stated to be a somewhat rare one, and was found in the filter beds in such quantities as to form a complete coat, and to cause frequent renewal of the beds.

PARIS

Academy of Sciences, April 13.—M. Boulay, President, in the chair.—Theorems relating to the actinometric functions of movable plaques, by M. Haton de la Goupillière.—Remarks on the skeleton of a cave hyæna (*Hyæna spelæa*) discovered by M. Felix Regnault, and presented to the Academy by M. Albert Gaudry. These remains, recently found in the Gargas district, Upper Pyrenees, confirm the view already advanced by the author that the cave hyæna was merely a heavy variety of the *Hyæna crocuta* (spotted hyæna), still surviving in Central Africa.—On the pathogenetic and prophylactic action of the comma bacillus, by M. J. Ferran. From experiments made on several human subjects, whose names are given, the author concludes that by hypodermic injections of this germ, man, as well as the guinea-pig, may be infected with true cholera morbus, and that immunity from further attacks may be obtained by such injections in more or less graduated doses. He proposes to repeat the experiments here described in the presence of a Commission appointed by the Academy.—On the so-called "herpolhodie," a transformation on the fixed cone of the "polhodie," already described, by M. A. Mannheim.—Further results in the theory of matrices: their distribution into species, and formation of all the species, by M. Ed. Weyr.—A new method of determining the constants α, γ, δ, of the large mirror M of the sextant, by M. Gruey.—On the law of densities in the interior of the earth, in connection with M. Tisserand's theory of the figure of the earth, by M. R. Radau.—Resistance experienced by an indefinite circular cylinder immersed in a fluid to move as a pendulum in a direction perpendicular to its axis, by M. J. Boussinesq.—On the phenomena of diffraction produced by an opaque screen of rectilinear outlines, by M. Gouy. Two points are considered: the diffraction of light within the shadow of the screen when the ambient medium is more refringent than the atmosphere, and diffraction without the shadow of the screen.—On the phenomena presented by the permanent gases when evaporated in vacuum; on the limits within which the hydrogen thermometer may be employed, and on the temperature obtained by the explosion of liquefied hydrogen, by M. S. Wroblewski.—Influence of dilution on the coefficient of lowering of the freezing-point for substances dissolved in water, by M. F. M. Raoult.—On the vibratory forms of square plaques, by M. C. Decharme.—Description of some important improvements recently effected in the gas-heated thermo-electric pile invented in 1874 by MM. Clamond and J. Charpentier.—On a new electric pile acting with two fluids, by M. A. Dupré.—On the diurnal variation of the magnetic elements at the Parc Saint-Maur Observatory during the years 1883 and 1884, by M. Th. Morceaux.—On the depths to which the solar rays penetrate in marine water, by MM. H. Fol and Ed. Sarasin. From a series of experiments made in the month of March, 1885, at Villefranche-sur-Mer (Mediterranean) analogous to those previously carried out at the Lake of Geneva, the authors conclude that in fine weather the last rays of light are dissipated in the Mediterranean at a depth of about 400 m. below the surface.—On a remarkable deviation of the trajectory of a cyclone observed last February on the north-east coast of Madagascar, by M. Pelagaud. Almost for the first time since the Indian Ocean has been visited by Europeans—that is, the last four hundred years—a cyclone has visited the Island of Madagascar, causing great damage to the French fleet and other shipping along the north-east coast.—Note on the oxides of copper, by M. Joannis.—On the mutual attraction of bodies in solution and solid bodies immersed in the fluid, by M. J. Thoulet. In this second note the author shows that such mutual attraction exists that it is instantaneous, and that in the normal conditions it is directly proportioned to the surface of the immersed solid.—On a new process for preparing cyanogen, by M. G. Jacquemin.—Quantitative analysis of cyanogen mixed with carbonic acid, nitrogen, oxygen, and other gases, by the same author.—On the primary haloid derivatives of ordinary ether, by M. L. Henry.—On the existence of a nervous system in the Peltogaster: a contribution to the history of the Kentrogonides (Rhizocephals of Fritz Müller), by M. J. Delage.—On the nervous system of the Bothryocephalids, by M. J. Niemiec.—Notes on three new species of Ascidians from the coast of Provence, by M. L. Roule—A new contribution to the question of boric acid of non-volcanic origin, by M. Dieulafait. It is shown that boric acid is not always of volcanic origin, but that vast quantities exist in the salt lakes and saline marshes, all the elements of which are of a sedimentary character, and which amid more or less complex physical and chemical changes have still their first origin in the evaporation of normal marine basins.—On some specimens from a remarkable fossil forest in the Reserve of the Navajos Indians, Arizona, by M. E. Desté.—Note on the springs in the district of Gabes, North Africa, by M. L. Dru.—On the work being accomplished at the station of Kondoâ, established by the French section of the African International Society, by M. Bloyet.—On the influence of the nervous system on the temperature of the body, by M. Ch. Richet.—Studies on the inhalation of formene, and of monochloruretted formene (chloride of methyl), by MM. J. Regnault and Villejean.—On the harmless character of the comma bacillus, and on the presence of its

germs in the atmosphere, by M. J. Héricourt. The author finds that these organisms are normally present in all kinds of water, and in the form of spores or germs everywhere in the atmosphere. There are many varieties, some apparently identical with the comma bacillus of cholera.

BERLIN

Physical Society, March 6.—Dr. Kalischer described a new secondary battery intended to overcome the disadvantage of the usual accumulators, namely, that the sheet of lead used as anode got very soon destroyed. This object he attained by adopting a very concentrated solution of nitrate of lead as electrolyte, and iron as anode. The iron, on being immersed in the solution of lead, became passive and resisted every corroding effect of the fluid; in other respects the peroxide of lead on the electric charge became deposited at the anode as a very firm coherent mass enveloping and protecting the iron on all sides. The charge was continued till the greater part of the nitrate of lead was decomposed, a condition which was marked by the occurrence of a greater development of gas at the anode. At the beginning of the charge all development of gas must be avoided, as otherwise the peroxide of lead, or, more correctly, the hydrate of peroxide of lead, became covered with bubbles. As kathode a sheet of lead was used, but it was attended by two disadvantages. In the first place the lead, during the charge, separated itself at the kathode into long crystal threads, which soon passed through the fluid and produced short closing (of the current). In the second place the nitric acid, which remained in the fluid after the separation of the lead, acted very powerfully on the sheet of lead. Both disadvantages Dr. Kalischer avoided by amalgamising the kathode. This accumulator of iron, concentrated solution of nitrate of lead, and amalgamised lead yielded, after the electric charge, which could be carried out without any special preparations, a current of about 2 volts; after about six hours' discharge, however, the electromotive force sank to 1·7 volts, but, on the battery being left to itself for twenty-four hours, it became a little increased. According to the measurements hitherto taken, the functions of this accumulator were satisfactory. An attempt to substitute sulphuric manganese for nitric lead in this battery did not answer the purpose, as the peroxide of manganese separated itself, not in a continuous layer, but in loose scales.—Prof. Schwalbe laid before the Society a piece of a piezometer which had burst under a pressure of ten atmospheres. The rather thick glass was traversed by longitudinal fissures, distributed with perfect regularity and exactly parallel to each other.—Prof. Schwalbe further spoke of the ice-outcroppings, resembling asbestos and glossy-like silk, which emerged on old, decayed twigs and branches, and which he had observed in former winters. He supposed that they originated in the crystallisation outwards of needles of ice from the water in the interior of the wood under moderate and slowly advancing colds. This winter also, as in former winters, he had succeeded in effecting these glacial outgrowths artificially on some twigs, by impregnating them with water and then exposing them to a slow increasing cold of from $-2°$ to $-3°$. To test the accuracy of this hypothesis, he instituted experiments with solutions of salt. A solution of nitre gave very satisfactory results. When a decayed twig was thoroughly saturated with a solution of nitre, and then left to evaporate, there then cropped out on it delicate glossy protuberances, perfectly similar to those observed in nature on moist pieces of wood. In this last case it was impossible that any increment could come from the outside; these crystal needles could have grown only from the interior. With the cube-crystallising kitchen salt, on the other hand, the experiment did not succeed. The speaker related that the first observations of these ice outcroppages were made by the Duke of Argyll. The pillar-like outgrowths which in recent times had been largely observed by English naturalists, and which he had formerly observed and described, were, in the opinion of the speaker, likewise excrescences from the interior. —Dr. Kayser read a paper, sent in by Dr. Müller-Erzbach, in which the latter endeavoured to refute some objections raised against his experiments, communicated to the Society at the last sitting, respecting the magnitude of the sphere of influence of molecular attraction.

March 20.—Dr. Gross, starting from theoretical considerations, instituted the following experiment:—Two iron electrodes overlaid with sealing wax, in such a manner as to leave only the terminal planes free, were dipped into solution of chloride of iron, closed by means of a galvanometer into a circle, and any inequalities there might happen to be adjusted according to the Poggendorf-Du Bois-Raymond method. When now one electrode was surrounded by a magnetising spiral, there was seen, on its being magnetised, an electric current passing from the magnetic electrode through the fluid to the non-magnetic electrode. It might be thought that the current was a thermo-electric one, produced by the warming of the magnetising spiral; but a delicate thermometer showed that the air within the magnetising spiral was but 2° warmer than the surrounding air. Besides, the electrode that was to be magnetised was surrounded by a double cylinder, through which water of a temperature 12° below that of the air, was constantly flowing; and yet, notwithstanding this powerfully cooling influence, the current always passed from the magnetic to the non-magnetic electrode, whereas a thermal current must have passed from the warm to the cold electrode. The electric current was therefore produced, not by a difference in temperature, but by the magnetisation of the one electrode. The current continued so long as the electrode was magnetised. If the electrodes were now brought into a tube, and so arranged as to lie behind each other in the axis of the tube, with their free terminal planes turned to each other, then, on the magnetisation of one electrode, an electric current again set in, passing now, however, from the non-magnetic electrode, through the fluid, to the magnetic electrode. The direction of the current was consequently dependent on the direction of the magnetic axis to the electrolyte and the second electrode. As conducting fluid only sulphates of iron could be used in these experiments, and of these only such as received the free terminal plane of the electrodes nakedly. Dr. Gross believed that the currents demonstrated by him in the experiments thus described were related to the thermo-electric currents between magnetic and non-magnetic iron wires, which were a subject of study to Sir William Thomson.

CONTENTS

THURSDAY, APRIL 30, 1885

THE FOSSIL MAMMALIA IN THE BRITISH MUSEUM

Catalogue of the Fossil Mammalia in the British Museum (Natural History). Part I., containing the Orders Primates, Chiroptera, Insectivora, Carnivora, and Rodentia. By Richard Lydekker, B.A., F.G.S., &c. (London: Printed by order of the Trustees, 1885).

IN the above-named volume we welcome another contribution to the series of descriptive catalogues of the Natural History Section of the British Museum, which, initiated by the late indefatigable Keeper of the Zoological Department, Dr. J. E. Gray, have been energetically extended under the direction of his eminent successor, Dr. Günther, himself the author of the greatest of them all, the now classical "Catalogue of Fishes."

Unlike that valuable work, however, and the subsequently published catalogues of Chiroptera, of Birds, and of Batrachia, the volume before us does not conceal, under the modest title of "Catalogue," a systematic treatise on the orders dealt with, for it includes even less than its title implies, dealing only, as a rule, with the specimens of fossil Mammalia exhibited in the Museum galleries. We regret that this is so; an excellent opportunity has been lost by the author of bringing out a monograph, complete to date, of all the species of fossil mammals known—a work urgently needed not only by the student of palæontology, but by biologists in general, whose successful study of existing animals depends so largely on their knowledge of extinct forms.

Although the subjects of this work belong as truly to the zoological series as any of the groups of animals treated of in the catalogues of the Zoological Department above referred to, yet, as their remains which form the material on which it is founded are conventionally termed "fossils," the volume is prefaced by the learned head of the Department of Geology, Dr. Henry Woodward. This is, no doubt, as it ought to be, for Dr. Woodward is not only a distinguished palæontologist but a zoologist also; but the circumstance points to the uncomfortable fact that the collections on which it is based occupy a part of the house different from that of their nearest relations—a condition which, however convenient for departmental reasons, is none the less to be deplored as contrary to the principles which should govern the arrangement of a collection intended for instruction, and misleading to the general non-scientific visitor, who is necessarily led by such an arrangement to regard the animals, whose remains are presented thus to his view, as creatures of a parentage altogether distinct from that of existing species. We are confident that our opinions on this subject are shared by the able director of the Museum, whose arrangement of the specimens in the Hunterian Collection of the Royal College of Surgeons was based on the natural, as opposed to the artificial, system, such as we see adopted at South Kensington, which, however, existed there before his appointment, and which, no doubt, is still forced upon him by circumstances not under his control.

The Keeper of the Department of Geology is fortunate in having obtained for the preparation of this catalogue the services of one so competent to deal with the subject as Mr. Lydekker, whose valuable palæontological papers, published chiefly in the Memoirs of the Geological Survey of India, are so well known, and who appears to have brought to the study of the collection a mind unbiassed by theories of a bygone period of natural history, save in a few points which we shall presently point out, in which we trust he may have yielded rather to the respect due to the opinions of a former master of this science than to his own convictions.

The author premises (in the Introduction) that he has endeavoured, as far as possible, to follow in the lines laid down by Prof. W. H. Flower (in his "Catalogue of Specimens of Vertebrated Animals in the Museum of the Royal College of Surgeons," Part II., 1884) in respect to the nomenclature of species and genera and in regard to general systematic arrangement, and his wisdom in following such an excellent model is much to be commended. Unfortunately, however, the proviso "as far as possible" seems to have opened the way to some considerable exceptions to this good rule, which prove to be serious blemishes in a work otherwise well carried out. We can see no good reason why the simple plan of printing references in the body of the page, employed in all hitherto published descriptive catalogues of the Natural History Department, should have been abandoned in the volume before us in favour of a complicated system of foot-notes which disfigure the pages and causes the unlucky reader to keep his eyes perpetually on the move. Thus (to cite one of many instances), under the genus *Machærodus* we find arranged, in a narrow line down one side of the page, six synonyms, each provided with a minute number referring to a certain similarly numbered foot-note at the bottom of the page, in which, when found, the required reference may be made out. This trouble could have been spared the reader by simply printing the reference after the synonyms, and much space would also have been saved. But worse than this is the absence of even footnote references to synonyms, such as we notice in many places, as, for instance, under "*Hyæna striata*," where eleven synonyms with the names of their authors only, are arranged in a dismal line down the left side of the page.

Although the fossil remains are, in most cases, very carefully described, yet we regret to find but few definitions in detail of the families, genera, or species; for although definitions of still existing genera and species might possibly be omitted or much abridged, it is surely unadvisable in a descriptive catalogue to omit or abridge those of any of the truly fossil forms, however well they may be known to professed palæontologists. The author is occasionally unfortunate even in his short definitions, as, for instance, where he defines the genus *Crossopus* as having "teeth nearly the same in number as in *Sorex*, but different in colour," whereas this genus is really distinguished by having teeth nearly the same in colour as *Sorex*, but different in number (one premolar less on each side above). The expression "nearly the same in number" is curious in a scientific work. Under this genus we notice that *C. remifer*, which we considered had been long ago recognised as a synonym of *C. fodiens*, is given position as a distinct species, and, wonderful to

relate, it owes its recognition as such to two rami of the mandible!

We were at first puzzled by the numbers applied to certain premolars in the author's description of the dentition of some fossil species belonging to still existing genera, until the following paragraph in the Introduction was noticed:—"In enumerating the teeth of the typical heterodont Eutherian mammals, each tooth of the cheek series is referred to its proper position in the complete series, the first premolar always meaning the first tooth in the typical series of four, and so with the succeeding teeth." Mr. Lydekker has therefore resuscitated what we had thought was long defunct—namely, the Owenian system of expressing the homology of the teeth by imagining a fixed mode of reduction for a typical number of 44, of which the premolars, for instance, when reduced in number, are supposed to become so by symmetrical loss from before backwards; so that when, for example, two upper premolars alone remain, these must be considered to be the third and fourth. It is, however, an incontrovertible fact that in many species of mammals it is the third premolar in the upper jaw that is wanting, that further reduction is accomplished by the loss of the second, and, lastly, of the first premolar, the fourth premolar of the original series alone remaining, this tooth very rarely disappearing also. In the lower jaw of certain species with three premolars the second premolar is the first to disappear, so that here the same difficulty exists. Were the mandible of such a species to become fossil, the two remaining premolars would, by the Owenian system, be recognised as the third and fourth, whereas they would really be either the second and fourth or the first and fourth. Indeed Prof. Owen himself notices ("Anat. Vertebr.," iii. p. 374) that "in some instances the first premolar remains of small size when p. 2 and p. 3 are lost;" and Prof. Flower, commenting on the theory of reduction advanced by Prof. Owen, remarks ("Encycl. Brit.," xv p. 353) that "if this were invariably so, the labours of those who describe teeth would be greatly simplified; but there are unfortunately so many exceptions that a close scrutiny into the situation, relations, and development of a tooth may be required before its nature can be determined, and in some cases the evidence at our disposal is scarcely sufficient for the purpose."

Space will not admit of entering upon a criticism of the geological horizons adopted, which, so far as the Tertiaries of Europe are concerned, have been slightly modified by the author from the tables given by Gaudry, Boyd Dawkins, and Max Schlosser. We note, however, with satisfaction that he has rejected the prevalent notions as to the position of the Siwalik and Pikermi beds, referring the ossiferous strata of the former to the Upper and that of the latter to the Lower Pliocene—a view, if we mistake not, urged for some time past by Mr. W. T. Blanford. We could wish for a special note on the position of the Caylux and Quercy phosphorites of Central France, referred to the Upper Eocene; for the highly specialised character of the mammalian remains from these deposits appear to throw much doubt on their supposed age.

Where there is much to blame there is also much to praise: the descriptions appear to be in most cases excellent and carefully worked out, the subjects chosen for illustration well selected, and the woodcuts (thirty-three) well executed. We hope that this volume and the next (which will probably include the remaining species of fossil Mammalia represented in the collection) will together form but a "Prodromus" to a catalogue of fossil Mammalia by the same author, which, while equalling in comprehensiveness the best of the hitherto published catalogues issued by the Trustees of the British Museum, shall, however, surpass all of them in accuracy of description and in the number and excellence of its illustrations.

THE SELF-INSTRUCTOR IN NAVIGATION

The Self-Instructor in Navigation and Nautical Astronomy for the Local Marine Board Examinations and for Use at Sea. With numerous Examples, Illustrations, Diagrams, and Charts. By W. H. Rosser. New and Thoroughly Revised Edition. (London: Imray and Sons, 1885.)

BOOKS of this character have presumably their use; and this particular one is neither worse nor better than many others which owe their being to the necessities of the examination room rather than to the wants of the practical navigator. Its table of contents is framed according to the schedule of the Board of Trade; and though it is spoken of in the preface as "adapted for use at sea," Mr. Rosser has proved in other books that he knows it can be so considered only as an indirect compliment to the Board of Trade Examinations, which have been carefully devised so as to call for the greatest possible amount of cram and the smallest possible amount of real knowledge. The "Self-Instructor" has run through many editions, and no doubt answers the purpose of the author sufficiently well: it is, he says, essentially practical and not theoretical; though he omits to say that practical is to be understood as referring to what is wanted for the examination, and that theoretical refers to any reasoning or intelligent mode of working. It is not Mr. Rosser's fault that the examination is laid down on such clumsy and really unpractical lines; and what he has professed to do he has done fairly well: though it would be as well to expunge from future editions the symbol given on p. 2, for the "observed distance between the sun's near limb and the moon's far limb"; more especially if the symbol is to be used, as on p. 304, for a distance observed to the moon's near limb.

As a little matter of history, it may be remarked that the statement on p. 364, that the method of determining the latitude by the altitudes of two stars on the same hour-circle was originally given by Mr. Bolt in the *Nautical Magazine* for 1874, is not quite accurate. Mr. Bolt, in the article referred to, makes no claim of originality, but merely says that the problem may be new to many even expert calculators. In point of fact, the method suggested itself to, and was taught and practised by, the writer of this notice in 1859, and was introduced by him into the examination papers of the Royal Naval College in 1866; since which time it has been repeatedly set as a theoretical question. In reality, it ought only to be so considered; for though it gives very good results, and the observation is by no means a delicate one, a rough approximation to the interval of time being quite

sufficient, still the method is only available on a comparatively clear night; and though the same sights may possibly be also used for the determination of longitude, it will more commonly happen that the complete position may be satisfactorily determined by Sumner's method applied to two stars having a considerable difference in azimuth.

The pages in which Mr. Rosser treats of Sumner's method are of themselves sufficient to establish what has been already said as to the practical nature of the book. In an admirable monograph published two years ago, under the title of "Stellar Navigation," Mr. Rosser has shown himself alive to the very great value of this method of determining a ship's position, and to the necessity of shortening the calculation by the use of Sir William Thomson's special tables, or by Burdwood's and Davis's azimuth tables. But no remark in the "Self-Instructor" calls attention to this, and the problem is left, in its native clumsiness, in the form suitable to the questions of the examination room. The same might indeed be said of almost all other problems, which are given without any hint of the little artifices which, in practice on ship-board, render the computation quicker and easier. In saying this, however, we attach no blame to Mr. Rosser, unless it is for calling his book "practical," or "adapted for use at sea." The book is meant to meet the demands of the examinations; and for this, at least, it appears sufficiently well adapted.

J. K. L.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

On the Cause of the Dissimilarity between the Faunas of the Mediterranean and Red Seas

THE republication by Mr. A. H. Cooke of the list of Testaceous Mollusca obtained by the late Mr. Robert MacAndrew during a dredging excursion (in 1869) in the Gulf of Suez,[1] affords data for comparison with that of the Mediterranean over its eastern part, and of which the late Mr. J. Gwyn Jeffreys has, amongst other writers, given an account.[2] The extreme dissimilarity in reference to the species will, upon such a comparison, impress the mind.[3] I propose briefly to sketch out the process by which this dissimilarity may be supposed to have been brought about.

Going back to the Eocene period, we know that the whole of the region bordering the Levant, and including large portions of the three continents, formed the bed of the ocean, and we may presume that a community of genera and species existed over the whole tract represented by those of the Nummulite limestone of the Middle Eocene period.

During the Upper Eocene period there was a shallowing of the sea-bed in many places, and corresponding deepening in others, and thus the first division of the submerged area into deep and shallow basins would have been brought about with a certain influence on the animal and plant life; but the general result may not have been considerable.

It was during the succeeding Miocene period that the differentiation of the fauna and flora of the two seas really began. Recent observations on the geology of Northern Africa, Arabia, and Palestine by Zittel, Lartet, and others, leave little doubt that the Miocene period was one during which the main lines of the future lands and seas were marked out; and the absence of deposits belonging to this epoch (except a few scattered tracts formed of shallow-water and littoral beds) over the region referred to, leads to the conclusion that land-conditions prevailed very much where we now find them, and that the submerged areas of the Mediterranean and Red Seas were dissevered by the Isthmus of Suez. It was during this period of elevation that the differentiation proceeded; the original forms of the Eocene period developing in each basin independently of one another, and becoming more divergent as time went on. The process seems to have been continued well into the Pliocene epoch, but at a time which may be indicated perhaps as "Newer Pliocene" there occurred a re-submergence of the land to the extent of 220 to 250 feet below the present level of the sea, marked by the occurrence of raised sea-beds containing shells, &c., of species still living in the adjoining waters, and of old coast-cliffs perforated by Pholas borings, like that discovered by Oscar Fraas in the cliffs of Jebel Mokattam, near Cairo, at an elevation of 220 feet above the surface of the Mediterranean, and recently described by Dr. Schweinfurth (*Zeitsch. d. deutschen geolog. Gesellschaft*, 1883). During this depression Africa became an island, and the waters of the two seas were united.

With this union of the Mediterranean and Red Seas there must have been brought about a certain commingling of the forms inhabiting their waters respectively, and hence it is somewhat surprising that there should at the present day be found such an almost entire dissimilarity as that already stated. The explanation, it seems to me, is to be found in the fact that the strait was, in its shallower portion, very shallow; and that consequently, except for the purely littoral and shallow forms of marine life, a commingling really did not take place to any great extent. To the north of Lake Timsah there occurs a ridge of ground called *El Guisr*, which rises 70 feet above the present sea-level, and another called *Tunum*, which rises 25 feet. These ridges would have caused a shallowing of the strait to the extent of their elevation, so that over the former ridge the depth of the strait would only have amounted to 180 feet or less during the greatest submergence. It is impossible to say whether these ridges are higher, or the contrary, than they were at that period; but it is a remarkable fact that the sub-fossil shells in the gravels to the south of Tunum are those of the Red Sea, and to the north those of the Mediterranean; other ridges, like that of Tel-el-Kebir, produced similar shallows. As a general result it is clear that the submersion of the isthmus during the later Pliocene period did not produce a general commingling of the forms of the two seas; and when ultimately the seas were again separated by the re-elevation of their beds, and the present isthmus established, those forms which may have passed across from sea to sea would succumb to the altered conditions of their environment. It can scarcely be doubted that the temperature of the water of the Red Sea differs considerably from that of the Mediterranean by several degrees, and the forms which belong to the former would perish in the latter, and *vice versâ*. It would be interesting to ascertain which of the two faunas more closely resembles that of the original Eocene stock.

Here, then, we have the remarkable zoological phenomenon of two perfectly distinct sets of marine forms originating in one stock only as far back as the Middle Eocene period, independently developing to such an extent that, at the present day, there are scarcely more than eighteen species (according to Prof. Issel) common to both. Now, if the beds of these two seas (the Levant and Red Sea) were to be elevated into land and their fossil contents studied by a geologist of the future, he would probably assert on the palæontological evidence that they belonged to two distinct periods of geological time! This is subject matter for reflection, at least for geologists of the present day. I may add that I have been induced to try and solve to my own satisfaction the problem here presented while engaged on a work containing the scientific observations and conclusions made during the recent expedition to Arabia Petrea in connection with the "Palestine Exploration Fund."

EDWARD HULL

[1] *Annals and Magazine of Natural History*, vol. xv. p. 322 (fifth series).
[2] *Ibid.*, vol. vi. p. 65 (fourth series).
[3] This fact has been recognised by Prof. Haeckel in his "Visit to Ceylon" and his "Arabische Korallen," &c.

Hybridization among Salmonidæ

I PERCEIVE in NATURE (vol. xxxi. p. 563) that the "National Fish Culture Association" propose cross-breeding land-locked salmon and trout as proposed by Prof. Brown Goode in "Forest and Stream," August 7, 1884. Before doing so I would venture to direct their attention to a few points.

"Land-locked salmon" is admitted to be a race of the true *Salmo salar*, which from some cause having lost its migratory instinct, now lives in lakes, never migrating seawards, while its size is less than that of its sea-going relative. But as the two species are really the same, a cross between a land-locked salmon and a trout in fish-cultivation would be identical with a cross between a *Salmo salar* and a trout.

What then has been the result of attempting the latter cross at Howietown during the last few years? November 25, 1879, this was effected between salmon milt and Lochleven trout eggs; up to now all the offspring have been sterile, none have attempted to spring out of the ponds, and the largest fish among them last year, although in good condition, was only 16½ inches long. On December 24, 1881, this cross was again made, with similar results, the largest fish last winter being about 12 inches long. (Examples are in the South Kensington Museum). Sterility, I may remark, was anticipated from this cross, while it was supposed that such would remove the anadromous instinct, and these results have occurred, but as regards improvement in size, such has not, so far, proved a success.

A cross was made between a young salmon par and a Lochleven trout, on November 29, 1883, but the young succumbed to blue dropsy of the sac. This cross was again tried November 14, 1884, when the par was a year older, and so far the young look well, but we can scarcely anticipate their proving fertile offspring. I say "scarcely," for we know that domestication eliminates sterility in some races of hybrids, and in this instance the par had been raised from eggs at Howietown; these have now grown into grilse without descending to the sea, and given eggs. Eggs thus furnished from Howietown-raised grilse have hatched, and several thousand young par are in the establishment, the future of which race will be an interesting study.

I think I am justified in advising that when crossing salmon with trout, not to select a parent from a river or lake, but, if possible, to obtain eggs or milt from a race of salmon which has been two or more generations in a semi-domesticated condition, as with such the probabilities of failure are considerably lessened, but, so far as I have witnessed, hybrids between salmon and trout have proved sterile and undersized.

Cheltenham FRANCIS DAY

Forms of Leaves

IN a recent issue of NATURE, in the discussion on the forms of leaves, Mr. Henslow seems to doubt the assertion of Sir John Lubbock that the holly produces prickly leaves on the lower branches, and smooth leaves without spines above; but this is a fact which may easily be verified in numerous localities (selected gardens varieties are of course not intended). I know of a large tree at Kew which altogether confirms the statement. The explanation, however, that the spines of the lower leaves may be produced to prevent animals from browsing on them, and that they are not developed on the upper branches because these are beyond the reach of animals, seems to me to require some modification, if not to be given up altogether, in this limited sense. It seems to me to admit of a much simpler explanation, namely, that it is an approximation—or reversion, if indeed the term be applicable—to the ancestral type. It is a well-known fact that in the embryonic stage of an organism the affinity with the ancestral type is best seen, and that in the mature stage the greatest amount of specialisation takes place; and, viewed in this light, the case of the holly does not appear to present much difficulty. A young seedling is seen to have very spiny leaves, but with increasing age the leaves becoming comparatively spineless. In the case of the furze we have the most overwhelming evidence that the spiny character has been developed to repel the attacks of herbivorous animals, and a young seedling is seen to have trifoliate leaves—like the laburnam—from which we infer that its ancestral type was spineless, and had trifoliate leaves. The large group of phyllodineous Acacias bear an equally unmistakable stamp of their origin in the bipinnate leaves which the seedlings at first produce. In most cases these leaves are very early superseded by phyllodes, but in *A. melanoxylon* the habit of producing true leaves is never quite lost. There is a large tree of this species about 40 feet high at Kew, at the south end of the Temperate House, close to the spiral staircase. It is thus in an admirable position for examination. At the base of this tree the leaves predominate over the phyllodes, but in ascending the staircase the proportion is seen to gradually diminish, till at the top of the tree—a few feet above the gallery—scarcely a true leaf is to be seen. Assuming the mature stage to be the more highly specialised, we have in the holly a precisely parallel case. This necessarily involves the opinion that the ancestral type of the genus *Ilex* had spiny leaves; and, if so, it seems highly probable that the character was developed as a protection against the attacks of herbivorous animals. A possible objection which at first struck me was that many of the species have quite smooth leaves; but this has been removed by a search through the specimens in the Kew Herbarium. In the first place, species with spiny leaves occur in each great centre of distribution of the genus—in North and South America, India, China and Japan, the Atlantic Islands, as well as Europe—and in the second, although no seedling plants were found, there are three species which show very spiny leaves on barren branches, and smooth leaves on the more mature flowering branches. These are *I. insignis* and *I. dipyrena*, from India, and *I. Perado*, from the Atlantic Islands. I have little doubt that seedlings of many species would present the spiny character if we could only see them. The presence of spines—the nerves being extended beyond the margin of the leaf—seems to indicate an excess of vascular over cellular tissue; a condition which is either modified with increasing maturity or is not exhibited in the same phenomena. In any case a severe pruning—or reduction of the parts to be nourished—is followed by a temporary reversion to the more spiny character. If this explanation be the correct one the question naturally arises, Why are the hollies losing the property of producing spiny leaves? rather than, Why does the holly produce spiny leaves on its lower branches? The answer to the first query would perhaps be, Because they no longer need the protection afforded by the spines. To the second, Long-continued habits are not often instantly laid aside.

Herbarium, Kew, April 18 R. A. ROLFE

Kite-Wire Suspended Anemometer Readings

HAVING lately made some observations with my anemometers elevated, as above described, at heights above the ground considerably greater than those mentioned in my paper before the British Association last year, I venture to think that a word or two as to the main point at present under investigation, viz. the general increase in the velocity with the altitude at heights between 600 and 1100 feet above the ground, may be interesting to your readers.

Up to June last the greatest altitude reached by the anemometers was 646 feet. I have lately been able to secure readings up to 1129 feet. Taking the average of seven of these, we get the following values for the mean relative velocities at two mean heights:—

Height in feet above ground.	Velocities in feet per minute.
1070	2297
756	2165

When these values are inserted in the formula $\frac{V}{v} = \left(\frac{H}{h}\right)^x$, we get for the value of the exponent $x = 0{\cdot}17$, or a little more than $\frac{1}{6}$; but when 500 feet—the elevation of the place of observation above the sea—are added to each elevation, we get $x = 0{\cdot}26$, or almost exactly $\frac{1}{4}$, which is the value I deduced for the exponent in NATURE (vol. xxv. p. 506), from a discussion of Dr. Vettin's cloud observations.

I would not at present lay much stress upon this coincidence until I have investigated the ratio up to heights of 2000 feet or more, but I certainly think it supports the notion that the formula with this exponent represents the average law of increase at heights over 1000 feet above sea-level.

E. DOUGLAS ARCHIBALD

Temperature of the Body of Monotremata

I HAVE found the temperature of the body of *Echidna hystrix* to be (average of three observations) 28°·0 C., and that of *Ornithorhynchus paradoxus* (two observations) 24°·8 C.[1]

These temperatures present a special interest, comparing them with the mean temperature of the body of mammalia in general, which is (after Dr. J. Davy's observations of thirty-one different species) 38°·4 C. N. DE MIKLOUHO-MACLAY

Biological Station, Watson's Bay, near Sydney, N.S.W., March 10

[1] Details of these observations can be found in the *Proceedings* of the Linnean Society of New South Wales, vol. ix. pp. 425 and 1204.

Quinquefoliate Strawberry

It may interest botanical readers to know that we have here a variety of strawberry many petioles of which bear five leaflets. This kind of leaf is also transmitted to its offspring when propagated by runners, and I think it may be possible to raise from seed progeny the whole of whose petioles will bear five leaflets. It is an excellent variety in every respect; the fruit is symmetrical, and of rich flavour. When we consider that Duchesne's strawberry, *Fragaria monophylla* (described by Mr. Dyer in NATURE, vol. xxix. p. 215), was unifoliate, and that ordinary strawberries are trifoliate, this variety certainly is unique, and suggests still further possibilities of development in the genus Fragaria.

J. LOVELL

Driffield, April 16

SOME OF THE METEOROLOGICAL RESULTS OF THE TOTAL SOLAR ECLIPSE OF MAY 6, 1883[1]

In the expedition sent by the United States Government to Caroline Island (9° 59′ 45″ S. lat. and 150° 14′ 24″ W. long.) to observe the total eclipse of May 6, 1883, provision was made for taking a series of meteorological observations on the occasion. The observations, which were of an elaborate description, are fully detailed and summarised by Mr. Upton in the Report, and they present results of exceptional interest.

During the eclipse the velocity of the wind remained practically constant, and, so far as the readings of the radiation thermometers showed, the heat received by the earth was almost *nil*. The temperature of the air, which, previous to the eclipse, had been 84°·5, fell to 81°·4, or 0°·1 lower than it had been at 7 a.m., and 0°·6 lower than it was at 9 p.m. The amount of the temperature depression due to the withdrawal of the sun's heat was 3°·9; and, corresponding with this lowering of the temperature, the relative humidity increased 5 per cent. during the eclipse.

The main interest of the observations, however, centres in the influence of the eclipse on the diurnal barometric curve. The diurnal march of the atmospheric pressure in these regions may well be classed among the most regularly recurring phenomena of terrestrial physics. From hourly observations made from April 25 to May 5 the mean at 10 a.m. was 29·957 inches, and at 2 p.m. 29·844 inches, the barometer thus falling in these four hours 0·113 inch. Between these hours, on May 6, the eclipse occurred, the total phase of the eclipse being from 11·32 to 11·37 a.m. On that day the barometric curve presented a form wholly different from what is daily observed in these regions. From 10·30 to 11·25 a.m. the barometer fell with a greater rapidity than the normal rate of fall, being at 11.20 a.m. 0·016 inch lower than the normal at that hour. Immediately thereafter a rapid and abnormal rise set in, the usual fall being arrested and replaced by an actual rise, so that while pressure at 11.20 a.m. was 29.927 inches, at 11.50 a.m. it was 29·940 inches. At 12.10 p.m. it was 0·019 inch above the normal for that hour. Since the barometer was 0·016 inch lower than the normal at 11.20 a.m., and 0·019 inch higher at 12.10 p.m., it follows that the disturbance from the normal values during these fifty minutes occasioned by the eclipse amounted to 0·035 inch, being equal to nearly a third of the whole diurnal oscillation from the morning maximum to the afternoon minimum.

The time and manner of this abnormality is of special significance, inasmuch as it indicates a more rapid fall than the average during the first partial phase, when the sun's heat began to be cut off, and a rise above the average wholly exceptional after the close of the total phase, the maximum rise being delayed thirty-three minutes after the period of totality. An eclipse differs essentially from all other influences affecting the atmosphere, in that it cuts off the sun's heat from a restricted section of the earth's atmosphere extending from the surface to the extreme limits of the atmosphere, while from the air surrounding the shaded region the sun's heat is not cut off. Now, the observations showed that the first effect of the cutting off of the sun's rays and consequent reduction of the temperature, which no doubt extended through the whole height of the atmosphere, was to lower the pressure below the normal. This diminished tension was simply the direct result of the lowering of the temperature of the air over the region where the barometric observations were made.

Following this diminution of the pressure, an inflow of air towards the retreating path of the shadow set in, and pressure quickly rose above the normal of the hour, and as the sun's rays now heated the air with this excess thus temporarily accumulated over Caroline Island, pressure rose still further, till at thirty-three minutes after the close of the total phase it was 0·019 inch above the normal. Thereafter pressure fell with a corresponding rapidity during the next twenty minutes, at the close of which time it stood at the normal. The whole phases of the disturbance in the diurnal march of the pressure caused by the eclipse occupied two hours ending with 12 30 p.m. It is from their bearings on the theory of the diurnal oscillations of the barometer that Mr. Upton's observations must be regarded as of the highest importance (see "Encyclopædia Britannica," *Meteorology*, pp. 122 and 123).

Pointed attention is given in the report to the observations of the wind, which showed that, though the island is situated in the region usually included in the south-east trades, yet the direction of the wind was almost always noted as east or north-east, and was at no time observed to be from any other quarter than between north and east. Not a single observation during the time the expedition was on the island gave a direction south of east. The *Challenger* in this part of its cruise, during September, 1875, noted the same directions of the wind, and during the cruise to southward the north-east trades were not left till lat 13° S. was reached.

During the voyage from Callao, the *Hartford* sailed day after day in the region of the south-east trades, upon almost the same parallel of latitude, and with but few changes in the position of the sails, no steam being used. Since the conditions were so constant during the twenty-two days in which the vessel sailed in lat. 11° 5′ S. from long. 79° to 137° W., a tabulation of the hourly speed of the vessel day by day has been made from the ship's log. The mean values show a distinct increase in the evening, and a corresponding decrease in the morning, the maximum, 6·8 miles per hour, occurring at 10 p.m., and the minimum, 5·9 miles, at 10 a.m. With reference to the result, Mr. Upton remarks that, "It seems fair to attribute this to a diurnal variation in the wind's velocity. There is quite an unexpected regularity in the progression when we consider the approximate nature of the method. If not attributable to diurnal change in the wind itself, it yet indicates a diurnal change in the effect of the wind upon the sails, and is therefore of interest."

[1] Report of observations made on the expedition to Caroline Island to observe the total solar eclipse of May 6, 1883, by Winslow Upton. (Washington, 1884.)

SIR WILLIAM THOMSON ON MOLECULAR DYNAMICS[1]

III.

Before proceeding with new parts of this subject, I wish to say a few words about "fiddling while Rome is burning." Sir William Thomson writes to me that the expression was used while discussing some mathematical triviality, and he wishes to be relieved of the imputation

[1] Continued from p. 510.

of speaking disrespectfully of *anomalous dispersion*, which he says is quite as important as *double refraction*. I grant this, but my interpretation of his language when I heard the lecture was that so many possible ways had been shown of explaining anomalous dispersion that it was mere child's play (or fiddle-playing) to discuss it while the burning question of double refraction awaited explanation, upon which question seems to depend the whole safety of the wave-theory of light, that theory being in imminent danger of destruction therefrom.

I shall now give a brief account of the gyrostatic molecules, crude and improved. The crude one is a fly-wheel inside a massless shell. Here there is no gyrostatic action opposing a motion of translation, but only opposing a motion of rotation. This is the molecule which was stated to give the wrong kind of variation of magneto-optic rotation with variation of wave-length. The improved gyrostatic molecule (p. 320) consists of two fly-wheels on one axis. But the axis is cut in two in the middle between them, and the parts fitted together by a ball and cylinder joint. The other ends of the half axes are supported in ball-and-socket joints in the massless shell. So far as rotation of the shell is concerned, this acts like one gyrostat, the axis always remaining in one line. But if the shell be frictionless, the ether can only give translational movement to it, and the double gyrostat produces a gyrostatic effect when the molecule is accelerated in any direction except along the axis.

The special function of this molecule is to explain magneto-optic rotation of the plane of polarisation. The axis of the molecule is supposed to be the direction of the lines of force. It is required to be proved that, gyrostatic molecules being imbedded in the ether with their axes parallel and their directions of rotation the same, the velocity of propagation of a circular disturbance going with the gyrostat is greater than that of a circular disturbance in the opposite direction. With a steady propagation of circularly polarised light, the gyrostats will clearly execute a precessional motion. The theory of this motion is examined after the manner of Thomson and Tait's "Natural Philosophy" for a ray along the axes, and the gyrostatic effect is found to be equivalent to altering the effective density of the molecule, and so altering the velocity of propagation. Thus if v and v' are the velocities of propagation along the axis of rays polarised circularly in the two directions, it comes out that approximately

$$\frac{v'}{v} = 1 + h\frac{\omega}{\gamma},$$

where h is a constant depending on the form of the gyrostats, ω is the angular velocity of the precessional rotation of the gyrostats, and γ is the velocity of rotation of the gyrostats. This is a totally different law to the action of the *crude* gyrostatic molecule, and is in accordance with experiment.

If now we have *improved* gyrostatic molecules imbedded in the ether, their minute rotations will affect the velocity of propagation in the manner of crude molecules, but their translations will affect the velocity in the manner now elucidated. But observe that by diminishing the size of the molecules the influence of the rotational motion diminishes, but the influence of the translational motion remains the same (on the assumption that the angular gyrostatic velocity is kept the same and the ratio of mass of gyrostats to mass of molecule remains the same). Hence, if we have small enough molecules, the law which agrees with experiment alone holds. This is a very satisfactory state of affairs, and I believe it is the first time that Sir William Thomson's hint about this phenomenon, so long ago thrown out, has been developed.

There is still so much matter in the lectures that I have not touched upon that I am in some difficulty as to what to omit. But I certainly should like to transcribe nearly the whole of the last lecture. This is of course impossible, but I will claim a little space for some remarks on Rankine's beautiful but futile attempt to get over the fatal difficulty of double refraction (p. 271):—

"Suppose here a massless rigid lining of our ideal cavity in the luminiferous ether. Let there be a massive, heavy molecule inside, with fluid around it. The main thing is that this molecule, which only affects the effective inertia of the ether by adding its own mass to the moving mass of the ether, has æolotropy of inertia. Imagine this spherule (drawing on the board an oblate spheroid with axis vertical) moving first in a horizontal direction. The effective inertia of this sheath will be altered if it moves to and fro in a vertical direction, there being, by hypothesis, liquid between it and the ether. The density of this mass must be greater than the density of the liquid, that is all. If there is danger of its coming to the sides of the cavity, let there be springs to keep it in place, if you like, but let its connection with the lining of the cavity be in the main through fluid pressure. Then its effective inertia is different in different directions. This fluid lining seems to hit off the very thing we wanted. Now comes Rankine's want of strength. He cut around the edges of it, and, I think, rather jumped at it, and put down a wave-surface the same as Fresnel's, and said that it came to that. But, alas! Stokes (long before Lord Rayleigh suggested it) showed that it would give a different surface from Fresnel's. Lord Rayleigh, in repeating Rankine's suggestion, showed his strength where Rankine was not so strong in mathematical powers of grappling with a difficult mathematical problem. Lord Rayleigh is a man who grapples with a difficulty and sees how much he can do with it. He puts it aside if he cannot solve it, but he never shirks it. Rankine was not a mathematician in that sense at all. Lord Rayleigh finds, not Fresnel's wave-surface, but a wave-surface differing from Fresnel's by certain terms appearing in reciprocals instead of directly."

Now Stokes has shown that Huyghen's construction satisfies experiment with great accuracy, and hence Rankine's effort fails. The desperate condition of the wave-theory is shown by the words penned by Lord Rayleigh before he knew of Stokes's experiments (p. 272): "Should the verdict go against the view of the present paper, it is hard to see how any consistent theory is possible which shall embrace at once the laws of scattering, regular reflection and double refraction."

It appears, then, that after all the labour which has been expended upon the wave-theory of light, it fails absolutely, and, as it seems, hopelessly, in two points of primary importance. One is the extinction of the ray polarised by reflection; the other is double refraction. In other matters we have difficulties, but we can see a possible means of escape. Here there seems to be none.

Before concluding this series of articles I wish to say a little more about the manner of their delivery. It is a rare experience for students to have the opportunity of studying the workings of a great mind while grappling with a problem. This is what occurred during the three weeks of the Baltimore lectures. During the whole of this period one or two ardent students were hunting up references in the Peabody Library, &c., and literally filled Sir William Thomson's rooms with the results of their searches, and Sir William generally read these books. He says (p. 76):—"An interminable number of books have been brought to me, and in every one of them I have found something very important." But at p. 98 he says:—"I got another quarter-hundredweight of books on the subject. I have not yet read them all through." In this way he often came for the first time upon researches bearing on the question in hand. Thus (p. 77): "I only found this morning that Lommel also goes on to double refraction of light in crystals [with imbedded molecules]. The very problem I am breaking my head

against." Evidence is always cropping up that the author is in the habit of going farther into a subject by original mathematical analysis than by reading up other people's work. I will give some examples. Speaking of a reference by Rankine to cubic asymmetry, he says:—"I only came across this in Rankine two or three days ago. But I remember going through the same thing myself not long ago, and I said to Stokes—I always consulted my great authority, Stokes, whenever I got a chance—'Surely there may be such a thing found to exemplify this kind of asymmetry; would it not be likely to be found in crystals of the cubic class?' Stokes—he knew almost everything—instantly said: 'Oh, Sir David Brewster thought he had found it in cubic crystals, but there was an explanation that it seemed to be owing to the effect of the cleavage planes or the separation of the crystal into several crystalline laminæ'" (p. 158). Then again he says:—"I am ashamed to say that I never heard of anomalous dispersion until after I found it lurking in the formulas. I said to myself, 'These formulas would imply that, and I never heard of it;' and when I looked into the matter I found, to my shame, that a thing which had been known by others for eight or ten years I had not known until I found it in the dynamics" (p. 120). Once more we find:—"I was thinking about this, three days ago, and said to myself, 'There must be bright lines of reflection from bodies in which we have those molecules that can produce intense absorption. Speaking about it to Lord Rayleigh at breakfast, he informed me of this paper of Stokes's, and I looked and saw that what I had thought of was there. It was known perfectly well, but the molecule first discovered it to me. I am exceedingly interested about these things, since I am only beginning to find out what everybody else knew, such as anomalous dispersion, and those quasi colours, and so on" (p. 282).

The purely physical bent of the author's reasoning is well shown in speaking of Rankine's work at p. 270: "I do not think I would like to suggest that Rankine's molecular hypothesis is of very great importance. The title is of more importance than anything else in the work. Rankine was that kind of genius that his names were of enormous suggestiveness, but we cannot say that always of the substance. We cannot find a foundation for a great deal of his mathematical writings, and there is no explanation of his kind of matter. I never satisfy myself until I can make a mechanical model of a thing. If I can make a mechanical model, I can understand it. As long as I cannot make a mechanical model all the way through, I cannot understand; and that is why I cannot get[1] the electromagnetic theory. I firmly believe in an electromagnetic theory of light, and that, when we understand electricity and magnetism and light, we shall see them all together as part of a whole. But I want to understand light as well as I can without introducing things that we understand even less of. That is why I take plain dynamics. I can get a model in plain dynamics, I cannot in electromagnetics. But so soon as we have rotators to take the part of magnets and something imponderable to take the part of magnetism, and realise by experiment Maxwell's beautiful ideas of electric displacements, and so on, then we shall see electricity, magnetism, and light closely united and grounded in the same system."

The model of an electromagnetic ether described by Prof. Fitzgerald on March 28 to the Physical Society, founded on Clerk Maxwell's celebrated papers in the *Philosophical Magazine* in 1860 and 1861, goes a long way to clear away the objection raised by Sir William Thomson.

In reading these lectures, it must be remembered that they are uncorrected *verbatim* reports, and one is surprised at seeing that the matter is so continuous and readable. A considerable freshness is given by the conversational interludes and remarks, which would not perhaps have appeared in a written work. As mentioned before, Sir William spoke of the pressural wave as an animal; this was very happy, as he had just before called it the *bête noir* of the mathematicians. He says at p. 34:—"I do not like the words 'paradoxical phenomenon.' 'Curious phenomenon' or 'interesting phenomenon' would be better. There is no paradox in science. We may call it a *dynamox*, but not a *paradox*" At p. 115 he says:—The struggle of 1815 (that is not the same idea as *la grande guerre de* 1815) was, who was to rule the waves, Cauchy or Poisson?"

To many it will seem, after reading these lectures containing a review of what has been done and suggestions of what might be done, that certain facts are hopelessly irreconcilable with the wave-theory of light. Sir William Thomson has certainly not shirked a single difficulty, and perhaps has even made them look more glaring than is necessary. But, if this be an error, it is on the right side.

The reporter has introduced into the volume some doggerel rhymes read by a certain student of the lectures at a farewell dinner at Baltimore given by President Gilman:—

The Lament of the Twenty-one Coefficients at parting from each other and from their Esteem'd Molecule

An æolotropic molecule was looking at the view,
Surrounded by his coefficients twenty-one or two,
And wondering whether he could make a sky of azure blue,
With plagiotatic *a b c* and thlipsinomic *Q*.

They looked like sand upon the shore with waves upon the sea,
But the waves were all too wilful and determined to be free;
And in spite of *n*'s rigidity they never could agree
In becoming quite subservient to thlipsinomic *P*.

Then web-like coefficients and a loaded molecule,
With a noble wiggler at their head, worked hard as Haughton's mule;
But the waves all laughed, and said, "A wiggler, thinking he could rule
A wave, was nothing better than a sidelong, normal fool."

So the coefficients sighed, and gave a last tangential skew,
And *a* shook hands with *b* and *c*, and *S* and *T* and *U*,
And with a tear they parted; but they said they would be true
To their much-belovèd wiggler and to thlipsinomic *Q*.

Signed, (*g*, *f*), A CROSS COEFFICIENT NOW ANNULLED

The social and scientific intercourse of these three weeks at Baltimore was an experience that will be forgotten by none of the twenty-one coefficients, and they all sympathised with Sir William Thomson in his concluding remarks at p. 289:—

"I am exceedingly sorry that our twenty-one coefficients are to be scattered, but, though scattered far and wide, I hope we will still be coefficients working together for the great cause we are all so much interested in. I would be most happy to look forward to another conference, and the one damper to that happiness is that this one is now to end, and we shall be compelled to look forward for a time. I hope only that we shall all meet again in some such way. I would say to those whose homes are on this side of the Atlantic, 'Come on the other side and I will welcome you heartily, and we may have more conferences.' Whether we have such a conference on this side or on the other side of the Atlantic again it will be a thing to look forward to—as this is to look back upon—as one of the most precious incidents I can possibly have. I suppose we must say farewell!" GEORGE FORBES

[1] These reports are generally quite *verbatim*, but I am sure Sir William Thomson is not responsible for this characteristic Americanism.—G. F.

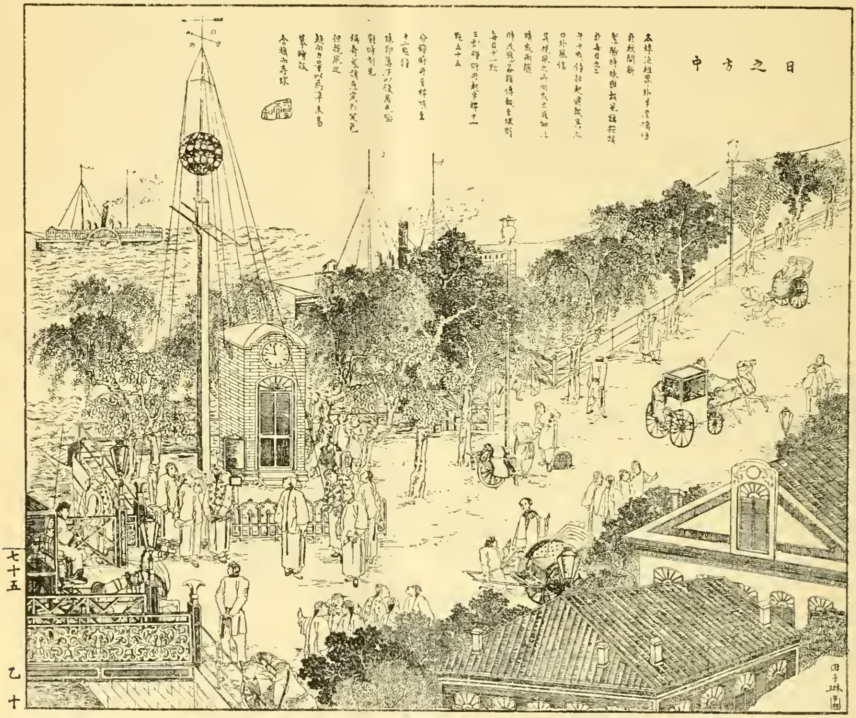
THE SEMAPHORE AND ELECTRIC LIGHT AT SHANGHAI

THE European and American community occupying the so-called foreign concessions in Shanghai has lately adopted the electric light. The illustration given

below is the reproduction of a Chinese drawing representing the light and a semaphore with a time-ball in the French concession. It is taken from *La Nature*, and originally appeared in a Chinese illustrated journal called the *Hu-pao*, which described the illustration in the following manner :—

"On the French concession, at the end of the settlements of the other foreign nations, a semaphore which marks the hour and the wind was erected last autumn. Every day at 10 o'clock a flag is hoisted which denotes the wind that is blowing on the sea at the mouth of the river. Every day at 11.45 a ball is raised to half mast, and five minutes before noon it is raised to the top. Precisely at noon it falls. In this way all the people of Shanghai can know the exact hour. The flags vary in form, in number, and in colour, according to the direction and force of the wind. Truly, it is a very good thing."

The illustration represents the semaphore to the left,



with the Chinese looking up at the ball which is about to be raised. The semaphore was erected on September 1, 1884, at a cost of 28,000 francs, by the French Municipal Council. It gives the hour at noon, and the force and direction of the winds at the mouth of the Yang-tsze-kiang. It is connected with the Zikawei Observatory, which receives the observations respecting the wind from Gutzlaff Island, at the mouth of the river, and which the director of the Observatory, Père Dechevrens, passes on by telephone to the assistant in Shanghai. The time-ball is in direct connection with Zikawei. The wires, poles, and lamps of the electric light are also noticeable in the illustration. The light, which was set up last year, appears for some reason not to be successful, and when the last mails left Shanghai the Municipal Council were in correspondence with the gas company with the object of coming to an arrangement for a return to lighting the streets with gas.

VARIABLE STARS

IN his stirring "Call to Friends of Astronomy" (*Schumacher's Jahrbuch*, 1844) to aid the advance of the science by taking up some definite department of work, Prof. Argelander, among other points for investigation, drew attention to the observation of variable stars as presenting a fascinating field of inquiry in which much valuable work might be done. Forty years have passed since this appeal was made. The list of eighteen stars visible in these latitudes then certainly known to be variable has grown to at least ten times the number, while a new "instrument of precision" has been placed in the hands of the observer in the form of the spectroscope, which has largely increased his powers. But, after all, it must be acknowledged that we are still greatly in ignorance of the causes which immediately underlie the striking phenomena which are presented to our view.

In taking a rapid glance at some of the phenomena with which we have to deal, it may be convenient to

adopt some form of classification of variable stars. The following arrangement suggested by Prof. Pickering will suit our purpose; but at the same time it should be remarked that links of association may sometimes be discovered between individual members of different classes in respect of some of their characteristics. It is probable, too, that after all some stars must remain unclassed.

"Class I. Temporary stars, or those which shine out suddenly, sometimes with great brilliancy, and gradually fade away. Examples: Tycho Brahe's star of 1572; new star in Corona 1866.

"Class II. Long-period variables, or those undergoing great variations of light, the changes recurring in periods of several months. Examples: *o* Ceti and χ Cygni.

"Class III. Stars undergoing slight changes according to laws as yet unknown. Examples: α Orionis and α Cassiopeiæ.

"Class IV. Short-period variables, or stars whose light is continually varying, but the changes are repeated with great regularity in a period not exceeding a few days. Examples: β Lyræ and δ Cephei.

"Class V. Algol stars, or stars which, for the greater portion of the time, undergo no change in light, but every few days suffer a remarkable diminution in light for a few hours. Examples: β Persei (Algol) and S Cancri."

The temporary or new stars form a remarkable class of stars, which blaze unexpectedly into view and then gradually decline. A striking object of this class was Tycho Brahe's star of 1572, which attained such a brilliancy as to be visible by day. It was not, however, till the year 1866 that a clue was found to the probable nature of these outbursts, when the examination of the spectrum of the new star which appeared in Corona Borealis in May of that year by Dr. Huggins suggested the view that in these cases the outburst is due to the liberation of large volumes of gas, which enwraps the star in a flaming envelope which gradually burns itself out.

The most recently-observed star of this type has a curious history. On September 24, 1876, the late Dr. Schmidt discovered, in the constellation Cygnus, a new star of the 3rd magnitude, which soon began to fade. Like the star T Coronæ it had a double spectrum. In September, 1877, when the star had fallen to 10·5 mag., an examination of its spectrum at the Earl of Crawford's observatory showed that the continuous spectrum had disappeared and that the star's light was monochromatic. In fact, to all appearance the star had become a minute planetary nebula!

The distinguishing characteristic of stars of this type, namely the temporary character of their phenomena, sharply marks them off from the variables of all the other classes, in which the changes recur with greater or less regularity. A connecting-link, however, may perhaps be found in the remarkable variable, U Geminorum, discovered by Mr. Hind in 1855. It has a very irregular period, which ranges between 70 and 126 days, during about three-quarters or more of which time it remains fluctuating about a minimum magnitude of 14·5. It rises rapidly to maximum (at the maximum of February, 1877, at the rate of over three magnitudes in twenty-four hours), and then, at first gradually and then more rapidly, falls to minimum again. Its colour has generally been described as bluish-white (though it has been noted ruddy), and a curious, ill-defined or hazy appearance has been noticed by several observers which would suggest the possibility of bright lines being found in its spectrum, a suspicion which has not as yet been confirmed.

Class II. includes by far the greater number of known variable stars. Many of these are highly coloured, showing tints of red or orange of various degrees of intensity, and among them are to be found stars having fine banded spectra of Secchi's types III. and IV. The regularity with which they go through their changes is of various degrees, and varies even in the same star at different times, while in some cases there is evidenced a tendency to form subsidiary maxima or minima on the main light curve. In some instances also the magnitude touched by the same star at maximum or minimum is subject to fluctuations, and this apparently quite independently of the degree of regularity with which the changes are gone through in respect of time. In two stars at least of this class—Mira Ceti and R Geminorum—bright lines have been observed in their spectra.

It is perhaps to be regretted that a separate class has not been formed for variable stars having a double period, with two equal or nearly equal maxima and two unequal minima, of which β Lyræ is the type. A star of this order, with a period of about 70 days, R Sagittæ, included in Class II. (though with an expression of doubt) in Prof. Pickering's list, seems to call for special remark. It was discovered by Mr. Baxendell in 1859, and his observations have shown first the approach to equality and then the reversal of the principal and secondary minima. The equalisation of the minima was also observed by Prof. Schönfeld, and their reversal by Mr. Chandler in America. The phenomenon thus exhibited is a remarkable one, though perhaps not unique, as something similar appears to have been noticed by Prof. Argelander and Prof. Schönfeld in the case of R Scuti.

Turning to Class III., a point should be mentioned in regard to one of the examples of the class α Orionis. Observing the star in March, 1866, Dr. Huggins noticed that "a group of lines and shading, as if of fine lines" had disappeared from its spectrum, the star at the time being at its maximum brilliancy. Six years later, however, Dr. Vogel, at Bothkamp, failed to detect any change of this character.

Passing to Class IV. we have, in one of the examples, β Lyræ, a star presenting points of singular interest. As has been already mentioned, its period of 12·9 days is a double one, with two equal maxima and two unequal minima, and Herr E. von Gothard, of the Herény Observatory, has discovered that its spectrum is also variable. Herr von Gothard has also observed the D_3 line (showing that Helium has a home in other suns than ours), and the lines of hydrogen as bright lines, and has further (*Astr. Nach.*, No. 2651) found them to vary in intensity in a period of about seven days. Further observation is required before any decided opinion can be expressed as to the relation between the variation of the spectrum and the variation of the star's light, but a comparison of Herr von Gothard's observations with the predictions of an ephemeris seems to suggest (though the evidence is not quite conclusive) that the bright lines are at their brightest when the star is near a minimum.

The stars of Class V., of which Algol is an example, form a group of variables of a well-marked type. The general features of their changes are fairly represented by the supposition of an eclipsing satellite. But in the case of U Cephei, a star of the group discovered a few years ago by Ceraski, a new feature is introduced which somewhat complicates the theory. Its period has been shown with some degree of probability to be a double one, with slightly unequal minima. Another curious fact which has been observed in regard to the star is that, as it falls below the 8th magnitude, its light becomes decidedly ruddy (indicating absorption as well as eclipse?), the ruddy colour being lost as the star rises to the 8th magnitude again, when it regains its ordinary brilliant bluish-white hue. It is only fair to remark that in Prof. Pickering's view the suggestion as to the duplicity of the star's period should be at present received with caution.

This brief review will suffice to show that any attempt to answer the question—What is a variable star?—involves the examination of a multiplicity of phenomena. At the same time, the causes presumably at work may be grouped broadly under two heads—geometric and chemico-physical. We have seen that in the case of the

temporary stars we have grounds for looking to the *latter*, while in the case of stars of the Algol group we have reasons for looking to the *former*, as a more or less probable cause of the changes we observe. While in β Lyræ we see that physical changes apparently accompany, if they are not connected with the cause of, the light variation. Is it to geometric or to chemico-physical causes that we are to look as the key to the explanation of the phenomena in other groups, say of the large group of Class II.? A few considerations will show the grave difficulties we have to meet. A difference of from five to seven magnitudes between the points touched by the star at maximum and minimum is to be found in the case of many members of Class II. Now, taking the magnitude scale at present generally adopted, having a light-ratio of 2·512, a range of five magnitudes would correspond to a difference of light-intensity in the proportion of 100 to 1, while if the range is extended to seven magnitudes, the star's light-intensity at maximum would bear to its light-intensity at minimum a ratio of 630 to 1. These wide differences of intensity of radiation are sufficiently startling if they are supposed to occur only once in a while, as in the case of the temporary stars. What are we to say of them if we are to suppose them to occur over and over and over again, in periods of from 150 to 600 days? The subject was discussed in these columns some few years ago, and the difficulties presented were felt to be so serious as to make it hard to accept a theory of this kind as offering a probable explanation of the facts if these stars are to be regarded as suns in the usual sense of the term, though less difficulty might be felt if we could look on them, not as suns in our sense at all, but as small bodies. In this case they would be relatively near to us, and would have a measurable parallax. An inquiry in this direction might prove fruitful. As compared with this theory, the theory that the changes of light may be supposed due to periodic obscurations by bodies or groups of bodies revolving around the variable, presents less formidable objections, though it has, of course, difficulties of its own. A few months ago one of our first authorities on the subject penned the words: "No theory has yet been advanced that will account satisfactorily for the ordinary phenomena of variable stars." It is possible that we must look forward to a future of more or less lengthened patient research before theoretic views can be announced which shall be anything much better than "guesses at truth."

It is, then, to further work that we must look for further progress, and the recent discoveries in regard to β Lyræ indicate one direction at least in which research should be made. Is it not possible that some valuable results might be obtained if the spectra of a selected list of variable stars were to be carefully studied with one of our largest telescopes — the several spectroscopic results being co-ordinated with the corresponding position of the star in its light-curve as fixed by a careful determination of its magnitude? In the discovery of new variables, the determination of their periods and range of variation, and of the general characteristics of their light-curves, good work may be done with instruments of very moderate dimensions; but for all but the brighter stars the spectra are too faint to be adequately treated but by instruments of the largest size.

Whether by this means any satisfactory results should be obtained or no, it is evident that in the study of variable stars a point has been reached whence, in order to secure any further advance, it seems needful by some means or other to endeavour to take a new departure.

THE LATE EARL OF SELKIRK

ON Saturday, April 11, 1885, Dunbar James Douglas, sixth and last Earl of Selkirk died, after a short illness, at St. Mary's Isle, Kircudbright: had he lived till the 22nd of the month he would have completed his seventy-sixth year. His death, though it occurred at a ripe age, has proved a sudden and unexpected blow to those who hoped that many years of life might yet remain to one upon whose spare and still vigorous frame, age had as yet apparently made but little impression, and whose mental and physical energy alike gave promise of a still prolonged period of utility. Those who so recently saw him in even more than his wonted health now sadly realise the fact that he has succumbed, like many others, to the evil influences of the treacherous and bitter east winds which for some time swept over our islands, and terminated his valuable life after a short illness of but three weeks. How much he is regretted, how sorely he will be missed, it is impossible to say; for the removal of one so gifted and so good is an irreparable loss, which will be felt more and more as time progresses, wherever the genial influence of his life and example had been felt

Elsewhere have been described his ancient lineage, his connection with various great families of historic fame, his political opinions, his public life, the high offices he filled in the State and in his county, the charms of personal character which marked his whole life; his education at Eton, his success at Oxford, his travels and explorations in almost every quarter of the globe; the rich harvest of experience he so assiduously collected and so carefully and accurately remembered; his thoughtful, unselfish nature, so loyal, so considerate of others, especially of the weak; so firm in assertion of all that he believed to be right, so excellent in all relations of public, private, and domestic life, so true a friend, so mindful of all who ever did or tried to do him the slightest service — all this may some day be told again in detail, but need not be dwelt on here in this brief notice, which contemplates rather the side of his nature which turned towards science and took so keen an interest in its progress and welfare, he himself being no mean contributor to its annals. Those who, like the writer, have had the privilege of intimate association with him, in the field, on the moor, in social life, and by the evening fireside, and have listened to his instructive conversation on many subjects connected with natural science, history, geography and biography, and have felt the satisfaction which arises from communion with one whose wisdom and experience seldom erred, who enunciated no crude theory, made no hasty generalisation on imperfect or insufficient data, and whose judgment was tempered, calm and reasonable in all matters submitted to it for decision, must feel that, by his death, science too has sustained a serious loss.

Lord Selkirk's great erudition and knowledge of men and nature were not derived merely from books. He was, indeed, a great reader, whose memory retained with extraordinary tenacity all the details even to minute particulars of that which he read: his vast stores of information were the result of much travel and study of physical science. Few, indeed, had travelled so far, or seen so much, or with such intelligent appreciation of what they did observe.

His mind was of a truly scientific mould, and accepted nothing on insufficient or imperfect evidence; his interest in all that was calculated to extend the limits of science was unbounded; but of all its departments, geology seemed to attract him most: he was a Fellow of the Geological Society, a frequent attendant at its meetings, and a contributor to its proceedings. One paper on "Sea-water Level Marks on the Coast of Sweden," read before the Society in 1867, was of much interest, and shows how closely he had studied that important subject. He was also a Fellow of the Royal Society, and took much interest in its proceedings, but deafness, which affected him early in life and increased with age, prevented him from taking an active part in the discussions of the learned societies, or in the debates in the House of Lords, and to a certain extent, therefore, disqualified him

from sharing in, though it in no way diminished the keen interest he felt in their deliberations.

The library in his beautiful and ancient home contained many works on science, literature, and art, but the great storehouse of knowledge was his own brain, and from this he was ever delighted to contribute for the instruction and amusement of his friends. All this, alas, has come to an end; the venerated form will no longer be seen where it was known so well, in the Isle, or in its picturesque surroundings overlooking the sea, but his memory will long be everywhere preserved in grateful recollection by his friends and countrymen. J. F.

RORAIMA

BY the kindness of Sir Joseph Hooker we ar able to give some illustrations relating to Roraima taken by Mr. Im Thurn during his recent successful expedition (aided by funds supplied by the British Association and Royal Geographical Society) to the top of the previously unscaled mountain. The following extracts from the paper read on Monday at the Royal Geographical Society, by Mr. H. J. Perkin, who accompanied Mr. Im Thurn, will give some idea of the work and results of the expedition :—

The 1st of December, our first day in Brazilian territory, we camped to the south-west of, and quite close to Waetipu, a splendid mountain towering above the general level of the table-land some 3000 or 4000 feet, with bold, sharp outlines ending in a well-defined peak, on its south side free from forest, the savannah continuing quite up to its summit, though densely wooded on its north-north-east and north-west.

From a lofty range of hills some 3600 feet high we had a splendid view of Waetipu, Roraima, Kukenam, Marima, and two small mountains near Waetipu, named Hormi and Mucureepa; the curious square, flat tops of Roraima and Kukenam, with their dark, precipitous cliffs, adding a grand and peculiar effect to the whole landscape. On December 2 we arrived at Toroikire or Ipelemonta, an Arecuna village of four houses situated on the left bank of the Arapu river.

The view from here is magnificent, as the village is placed just in front of Roraima, giving a sight also of Kukenam; it is situated on a high hill 3751 feet above sea-level, but is dwarfed by the gigantic walls of rock near it, Roraima being about four, and Kukenam about three miles from it Each mountain seems like a huge impregnable fortress, built on a mountain-top 7000 feet high, with walls from 1200 to 1800 feet in height.

The portion of Roraima facing Teroota is four miles long, and of Kukenam about the same. In wet weather their summits are wrapped in dark clouds, and after the rain is over and the clouds have dispersed the water can be seen casting itself over the cliffs in splendid falls that only by being seen can be at all imagined. At a distance of four to five miles they look like delicate white threads against the dark background of sandstone rock.

The two mountains are separated by a wide gorge, and in this clouds of dense white mist accumulate, and gradually creeping up as the day advances, enshroud their summits something after the manner of the "table-cloth" of Table Mountain.

The chief difficulty Mr. Im Thurn apprehended was from the dampness of the spot, as he feared he would be unable to dry the sheets of botanical paper used to preserve the specimens of plants he obtained, but by means of a large fire kept burning night and day this was easily accomplished.

Whilst on this first visit of ours to the upper portion of Roraima we saw on the face of the cliff itself a ledge of rock running up from the tree-covered portion of the highest sloping portion of the mountain to its summit; it appeared to us extremely easy to climb, except in two places: the first where the bush that covered the ledge appeared to end suddenly, leaving the cliff bare and naked, and giving the ledge the appearance of being interrupted, and consequently impassable; and in the second place where a waterfall from the summit falls on the ledge and has cut a gap in it, so that there seems to be a deep, wide hole, which it would take great trouble to bridge over. But on the whole it seemed so easy to climb the mountain here that we concluded there must be some insuperable difficulty of which we were not aware, for other travellers who had visited the mountain had stayed near this ledge, though, except Mr. Whitely, none of them attempted it, most of them having had to turn back soon after their arrival, owing to want of provisions, which latter contingency Mr. Im Thurn had particularly guarded against, and enabled us to stay some time and to make several excursions over the mountain-sides.

The north-east and west sides of Roraima are forest-covered, but on the south and south-west it is for the most part devoid of trees until a height of 5890 feet is reached, and from here up to the cliff-face the slope becomes far more steep and is covered by a thick, dense undergrowth: there are very few large trees, and even they are small when compared with the giant vegetation of the forests we had passed through.

Teroota village lies, so to speak, at the foot of the mountain, though the cliff portion is about four miles distant. Between Teroota Hill and Roraima flows the Kukenam river, which rises in Kukenam Mountain and descends from the summit in a splendid fall of about 1300 feet.

From the Kukenam river Roraima on its south-western side slopes up at an angle of about 20° to 4500 feet, and then at 30° to the commencement of the forest-covered portion to 5890 feet; from here to the cliff-face the incline is 15° steeper to about 7200 feet, and the remainder is cliff. At about 5600 feet we found a large piece of swampy ground filled with most exquisite varieties of orchids and ferns, and also the *Utricularia Humboldtii*, which grows to greater perfection here than on the Kaieteur savannah. Here also we found the Heliamphora or pitcher-plant, whose cup-shaped leaves were full of water; it bears a delicate white flower without smell.

We returned the same day, December 5, to Teroota, after our visit to Siedl.

We reascended the mountain on Sunday, December 7, and built our houses, one for ourselves and one for the men, at an altitude of 5405 feet above sea-level, close to Siedl's hut.

On the 10th, with Mr. Siedl, we went up a path cut by a Mr. Whitely in 1883, to the face of the cliff, and on our way, at 6410 feet, found a lovely flowering plant, the *Leiothamnus Elizabethæ*, of Schomburgk; it has deep carmine star-shaped flowers, with a white star centre, the points of which radiate down the petals. At 6841 feet we rediscovered another exquisite flower, first found by Richard Schomburgk, an Utricularia, with a large deep crimson blossom. The plant grows on the branches of trees, and is about 2 to 3 inches in height; the bloom, when but, completely hides the stalk, and is about an inch and a quarter long, by half an inch wide; sometimes there are two flowers on the same plant, but usually only one. The appearance of one of these bright blossoms on the sombre tree-branches has a most peculiar effect, and one's admiration is divided between the brightness of the flower and the wonderful energy of the tiny plant that produces it. Pursuing our way we reached the cliff at 12 o'clock, nearly three hours from the start, the way being extremely rough and steep, over root and trunks of trees, and bare rocks: at times we could hear water running among the stones under our feet.

There are no trees of any very great size growing on

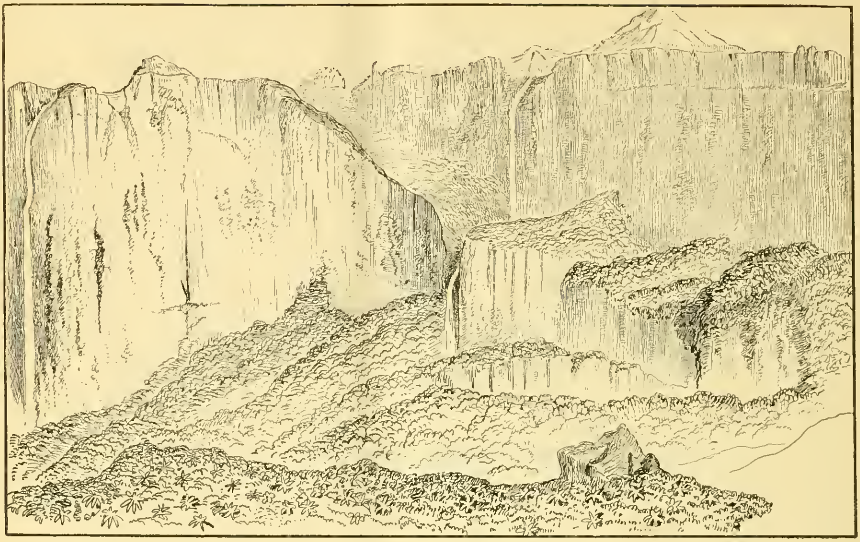


FIG. 1.—Part of south-west face of Roraima, showing ledge by which we ascended.

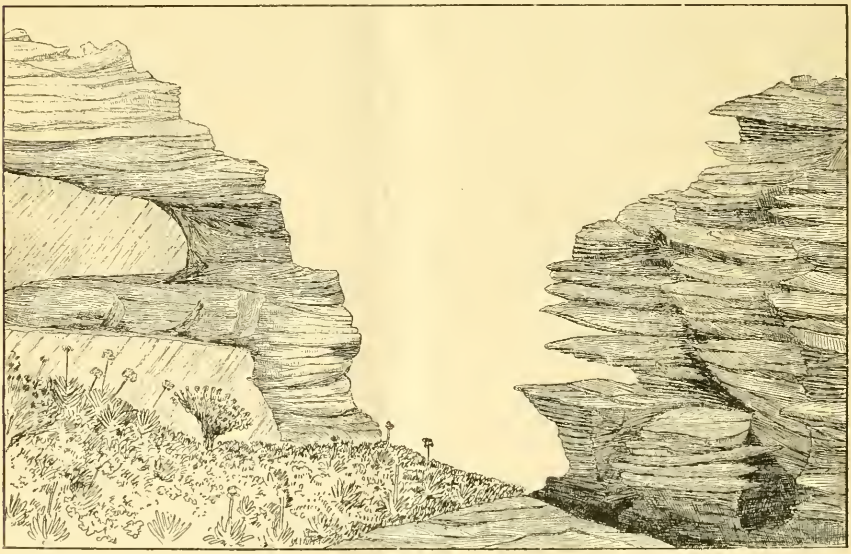


FIG. 2.—Scene at point of entrance on to plateau on top of Roraima.

that portion of the mountain, but the varieties of ferns are very numerous and beautiful, varying from small filmy to tall tree ferns, some 20 to 30 feet in height; but the plant that seemed to awaken for the time as much interest with us as any other, was the *Rubus Schomburgkii*, or Roraima blackberry, which greatly resembles the English bramble; we gathered several bunches of the fruit, which possibly does get sweet, but none of those we obtained were at all eatable.

From the portion of the cliff we reached we had a good view of the ledge we had seen on the 5th, and, though

Fig. 3.—Scene on top of Roraima.

partially obscured by the intervening bush, it seemed quite easy of ascent.

The height we reached this day was 7350 feet, determined by boiling-point thermometer, and it took us three and three-quarter hours to return to our hut, a distance of about two and a half miles, as we frequently stopped to collect ferns and other plants on our way.

On the 11th we ordered the Arecunas to cut a path to the foot of the ledge from the edge of the savannah, and if possible to continue it as far as the summit. After a day's work they returned, saying they had finished the road, but we afterwards found they had left off from fear of Makunaima, the great spirit, just at the point where the ledge joins the upper sloping portion of the mountain. This was on the 14th, when we reached 7756 feet above sea-level, and found our way suddenly barred by a precipice of 120 feet. A heavy mist, too, arose, and it became bitterly cold, with the rain falling in torrents, which rendered our return journey dangerous, and the path slippery and muddy.

The next few days were occupied in surveying the country around the mountain and preserving plants; it was still too wet and slippery to enable us to make any further attempt on the mountain, but, learning from Simon, the Arecuna chief of Toroiking, that the rainy season was about setting in, we determined to make use of the first fine morning we might have; and on December 18, which dawned most auspiciously for us, we left our house after an early breakfast at 7 a.m., reaching the cliff at 8.30, where we waited for about half an hour, and then set forward along the ledge, the path keeping much the same the whole way over rocks and roots and trunks of trees, and sometimes along the slippery leaning stems of the trees, using our hands and knees for some portion of the way.

The Arecunas we had with us hung back when we got thus far, and for a long while would not proceed, until, by dint of persuasion and the promise of a taste of ardent spirits, we prevailed on them to accompany us; we had, however, to send one of the men from the Pomeron, a half Negro, half Indian, to go first and lead the way, cutting a path as he went on. In this way we reached the waterfall, which to our great surprise we found extremely easy to pass, as the ledge was not cut away by the action of the water falling on it, and fortunately there was very little water coming over, being more like a very heavy shower, which wet us to the skin immediately. The foothold around the spot was extremely precarious, being worn quite smooth and slippery by the constant moisture and falling water.

From this fall to the top the last portion of the ledge slopes at an angle of 30°, and is in places quite twenty or more yards in width; it is covered by a dense growth of moss, and in spots tall coarse grass, which gives way here and there to flowering plants and small shrubs. Of the flowers one in particular, a species of heath, took our fancy by its dark pink blossoms of six petals, about the size of a halfpenny, which lay in quantities along our path.

So occupied were we in securing each new treasure that we had almost gained the top before being aware of it, for near the summit the ledge loses its steepness and is, so to speak, merged into the top itself.

A curious sight met our eager gaze as we passed the boundary line of the unknown—on all sides were grouped rocks of every shape unimaginable, weird, strange, and fantastic, first a row of huge oblong stones that looked like rude cannon placed there to guard the approach; further on another rock like a giant's umbrella on a short thick stem of about four or five feet in height, and others like miniature castles and ruins of old churches, leaning so much that had they not been solidly connected portions of the enormous sandstone bed, they would have fallen. We saw no lake, however, but several pools of water here and there. The vegetation on the summit was extremely scanty and insignificant. There being no trees, only small bushes from three to six feet in height, growing at long intervals and, with the exception of a few scrubby orchids, two species of thick-leaved ferns and a variety of the red Utricularia from below, there was no other plant there, owing, no doubt, to the absence of soil: for it is not possible for earth to collect on the summit, as it would be almost immediately carried over by the rain-water which finds its way over the edge of the enormous cliff

soon after it has fallen in most splendid waterfalls, some of which have a clear fall of 1500 feet.

We had no sooner accomplished the ascent than an impenetrable cloud of mist enveloped the whole of the upper part of the mountain, entirely obscuring the view, and rendering it difficult to see beyond forty or fifty yards in any one direction, and putting a limit to our wanderings.

After boiling the thermometer, which registered 197° F., the average of five readings, and gave the height (allowing for difference of temperature from sea-level) as 8600 feet, we returned to our hut, but not before I had tried with true British instinct to carve my initials as a memento of our visit; but I found the rock far too hard to permit of this, and had to content myself with leaving an advertisement torn from a newspaper of Messrs. Pears' soap and Madame Patt's testimony of its suitability for the hands and complexion.

In conclusion, I beg to present the Society with a few samples of rock and rounded pebbles, which I obtained in the course of our journey up the mountain. I have been told they lead to no very definite conclusion in a geological sense, as they seem to belong to no particular geological epoch, but are apparently agglomerations of deposits from various causes.

No fossils have been found, but several of these smooth pebbles which I found imbedded in the living rock on the summit point to its having been submerged at some long-passed time, but whether this huge mass has been obtruded by volcanic action, or the cliff has been bared of its at one time circumjacent soil by glacial or aqueous action, I leave for those skilled in geology to discuss, and shall be happy to give any further information that may lead to a more definite conclusion as regards the formation and age of the mountain.

One word more and I have finished: it is to again remind you that the whole success of the expedition is due to Mr. Im Thurn's excellent management and indefatigable zeal, as well as his intimate knowledge of the Indian character; and if my short notes have aroused your interest in Mount Roraima, I must ask you to accord a larger portion of the same to his complete and detailed report, which I have no doubt will ere long arrive.

NOTES

IT is well known to all acquainted with the British Museum, that the staff of the Zoological Department is very insufficient for the needs of so large a collection. In the vast subject of entomology especially the number of assistants is quite out of proportion to the mass of material necessarily accumulating with the advance of geographical exploration. We are glad to learn that a step towards remedying this state of things is about to be taken by the addition to the staff of an assistant, to be specially engaged upon the collection of Coleoptera. The conditions upon which the appointment will be filled up are announced in our advertising columns.

THERE seems to be at last some chance of the great Hume collection being received by the nation, as the British Museum has sent Mr. Bowdler Sharpe to Simla to pack and despatch the collection to England. Mr. Sharpe started by the last mail viâ Brindisi, and expects to be absent from England about four months.

DR. BENJAMIN APTHORP GOULD is to return to the United States very soon from South America, where he has recently completed the great works upon which he has been engaged for so long at the Observatory of Cordoba. His fellow-citizens of Boston, *Science* states, propose to give him a reception and a dinner on his return.

ON May 13 a statue of Linnæus will be publicly unveiled at Stockholm. The day will be the 178th anniversary of his birth.

REPORTS from Japan state that grave fears were entertained of an outbreak of the long quiescent volcano Fujiyama, and that officials had been sent to investigate the matter. The people living in the neighbourhood believed an eruption to be imminent, because, while the snow on the mountain had begun to melt two months before the usual time, all the wells at the fort became dry, and difficulty was experienced in procuring water. The phenomenon is considered the more remarkable from the fact that the winter has been unusually cold, and that the surface of the snow remains hard, the part nearest the ground being the first to give way.

INTELLIGENCE has been received in Amsterdam from Java of the eruption of the Semiroo mountain, the largest and most active of the Javanese volcanoes, situated on the confines of the Passoerean and Probolingo residencies. No mention is made of any loss of life having occurred.

PROF. FOREL, of Geneva, has sent us an account of an earthquake observed in Switzerland on April 13 last. It was composed of a preliminary shock at Neufchâtel between 9 and 10 o'clock, of a principal or great shock at 11.23 a.m., and of a succeeding shock observed at Lausanne and Geneva at 3.55 p.m. The principal shock disturbed a considerable area. It was felt in the district bounded by Geneva, Saint-Cergues, the Joux valley, Neufchâtel, Souceboz, Aarau, Schwyz, Interlaken, the Bernese Alps, Bex, and the Lake of Geneva. The detailed reports from the other cantons, Valais in particular, will extend still more the area of disturbance, which already includes a district 220 kilometres long by 100 broad, representing a superficial area of more than 20,000 kilometres. The main axis of disturbed surface is parallel to the chain of the Alps; in seismological classification this earthquake would therefore be put under the classification of longitudinal earthquakes. Over the disturbed area the shock was felt unequally. Thus in the cantons of Vaud and Neuchatel, the district which Prof. Forel is appointed to study, numerous and precise observations were received from Enhaut, Ormonts, the Rhone valley, the shores of the Lake of Geneva, from Villeneuve to Morges, then from Ginguis, Saint-Cergues, l'Orient de l'Orbe, Neufchâtel, Souceboz, &c., while none at all came from the valley of the Broil or of the Thièle, nor from Gros du Vaud. It would seem that the centre of the district remained quiet, while the borders were disturbed. The intensity of the shock was greater as one approached the centre, which was probably the valley of the Haut Simmenthal. There some damage was effected in the walls of houses; it is even said that rocks were detached from hills. This would represent a shock No. 8 in the scale which represents the intensity of earthquakes in ten numbers. In Prof. Forel's district the earthquake had very little intensity. The shock had three undulations, with some seconds' interval between each. In general the direction of the oscillations was indicated as parallel to the meridian, from north to south, or, according to the localities, as coming from north-east or north-west. A subterranean sound was heard in several places.

AT the conclusion of an article in a recent number of *Globus* on the Andalusian earthquake, Herr Willkomm refers to previous earthquakes observed in Southern Spain; for, although that of Christmas day last is the greatest and most frightful of them all in the historical period, it is by no means singular in other respects. The provinces of the kingdom of Granada, those of the kingdom of Murcia to the east of the latter, and the province of Alicante belonging to the old kingdom of Valencia, have frequently been visited by earthquakes. At Cape Roquetas

hardly a year passes without one. Judging from past shocks, Granada and the neighbourhood of Torrevieja and Guardamar in the south of Alicante, are the two main earthquake centres. From the last the shocks extend along the coast as far as Malaga. The most violent occurred in 1518 and 1829. On November 9, 1518, the town of Vera in Almeira was wholly destroyed, and in March, 1829, the towns of Guardamar and Torrevieja were converted into heaps of ruins. Malaga has been visited by earthquakes four times during the past century—viz. 1775 and 1777; October 8–10, 1790; January, February, and August, 1804, and August 4, 1841. In 1802, from January 17 to February 6, there were repeated shocks at Torre la Mota and Torrevieja; on July 9, 1822, at Cartagena, Murcia, and Alicante (over 200 shocks in twenty-four hours); on April 27, 1826, and until July of the same year, innumerable shocks in and around Granada. The whole population of Granada left the town and camped in the fields. Similarly for many other places in Southern Spain. If to all these be added the numerous earthquakes on the west of the peninsula, with centre at Lisbon, it will be clear that, next to Italy, no other part of Europe is so frequently visited by earthquakes as the south and west of the Iberian peninsula.

M. Cambou, a missionary in Madagascar, writes from Tamatave to *Cosmos* to report that on February 25, after a terrible cyclone, the coast of Madagascar, near Tamatave, was covered with pumice-stone and dust, in all probability, says M. Cambou, from the Krakatoa eruption. On March 28, 1884, similar pumice was found on the coast of Réunion. Subsequently, in the middle of May, the same phenomenon was observed on Mayotte, in the Mozambique Channel; and in September of last year it was noticed at Tamatave. Crystals of feldspath were mixed with the amorphous matter. The stones were generally small, the edges being worn round by attrition. A very few were of a pale reddish colour. According to the course of the currents in the Indian Ocean these would have been carried from the Straits of Sunda down to the 16th or 17th degree of south latitude in a south-westerly direction. Thence they reached Madagascar, and the adjacent islands, through the agency of the equatorial current and the trade-winds. The probability that this pumice is that of the Krakatoa eruption is supported by the following facts: the American frigate *Pensacola*, passing the Straits of Sunda on December 22, 1883, crossed large banks of pumice, and continued to sight smaller ones until January 10, 1884, when she was in 16° 7′ S. lat. and 66° 8′ E. long. The average speed of the current is stated to have been fifteen miles per day. Subsequently, on April 13, 1884, the French war-ship *Boursaint* met a bank of this pumice floating off the coast of Madagascar, in 14° 35′ S. lat., and 48°2′ E. long. The circumstances under which this pumice reached the Malagasy coast are specially interesting to ethnologists, as they afford a new proof of the possibility of human migrations to considerable distances. They also give some support to the theory that the Hovas of Madagascar are of Malay descent.

The Madrid Correspondent of the *Standard* writes that several doctors in Valencia have been making numerous experiments by inoculating adults and children with the choleraic virus. The faith of the local physicians and of persons of all classes in these experiments is so great that in one afternoon 300 persons were inoculated. The Scolapian Fathers brought all their pupils also for this preventive vaccination against cholera. The medical men say the same phenomena have been observed as were noticed in similar experiments in France last year during the epidemic. A commission of Madrid doctors has been sent to report on the experiments.

The Executive Council of the forthcoming International Inventions Exhibition at South Kensington has issued a most useful railway-guide and route-book, for the use of intending visitors. The district included is about forty miles in every direction around London, and the book gives for each station the number of trains daily, the fares, the average time occupied on the journey, the points at which to change for connection with the Exhibition, and the last two trains each day. It will be of great use to those numerous visitors who are not acquainted with the readiest and most convenient methods of getting from South Kensington to other parts of the metropolis and its suburbs.

We have received the second edition of Marion's "Guide to Photography," the first edition of which we noticed on its appearance. The text contains various additions, needed to bring it abreast of the latest photographic improvements.

We have received the Report of the Mason Science College, Birmingham, for the year ending "Founder's Day," February 23, 1885. The appeal issued last year for an additional endowment fund for scholarships and exhibitions, additions to the teaching staff, &c., has been met by subscriptions amounting to nearly 5000*l*. The free lectures to artisans appear to have been very successful, each lecture having to be repeated on account of the demand for tickets. It is interesting to notice that the chairman of the Academic Board reports that "the presence of ladies in the classes stimulates manly qualities in the students, and encourages gentlemanly behaviour." Besides prizes in all five languages taught, the ladies have distinguished themselves in physics this year. The fees for the evening classes have been diminished by one-half, being now threepence each lecture.

The National Fish Culture Association have transferred another large consignment of whitefish fry to the lakes in the Isle of Mull in order to further their acclimatisation to the waters of this country. Hitherto many experiments have been tried in this direction, but with no success. The American Government are rendering valuable assistance in effecting their propagation and are watching the result of the endeavours now being made with keen interest.

There will shortly appear, published by the Clarendon Press, "The Flora of Oxfordshire," including the contiguous portion of Berkshire, by G. Claridge Druce, F.L.S., &c. Over half a century having elapsed since the publication of Walker's "Flora of Oxfordshire," the many changes in nomenclature, the subdivision of species, and the great advance in botanical knowledge, demand a new work on the subject. Mr. Alfred French long ago commenced one, and on his premature death, in 1879, his MSS. came into Mr. Druce's possession. At the request of the Director of the Botanical Department of the British Museum, he undertook its completion. The "Flora" is intended to be not only a catalogue of the county species, with their localities, but also a history of them, and of the botanists connected with the University and county. About 400 species and varieties, additional to those given in Walker and Sibthorp, will be enumerated, and something like 20,000 records have been made in visiting nearly every parish in the county. The comparative plant occurrences in the counties of Berks, Bucks, Warwick, Northampton, and Gloucestershire will be shown. Orders should be sent to Mr. G. C. Druce, 118, High Street, Oxford.

A "Beginners' Star Atlas," by the Rev. T. E. Espin, with an introduction by Mr. J. A. Westwood Oliver, is in the press, and will be published shortly by Messrs. W. Swan Sonnenschein and Co.

In a paper read before the Academy of Sciences of Berlin at a recent meeting, Dr. G. Hellmann continued a paper read previously on certain regularities in the states of the weather in successive seasons of the year. The author, from a long series

of observations, draws a conclusion contrary to the current belief—viz. that a mild summer follows a mild winter. He studied the warm summers of Berlin from the year 1719 in one particular aspect—that is to say, with special reference to the succeeding winters. He regards that summer as warm when the temperature in June, July, August, and September, or at least in three of those months, is above the normal. Fifty-two such summers occurred between 1719 and 1885. Unfortunately there were certain gaps in the observations which could not be filled up; but there was no break in the observations between 1755 and the present, in all 130 years of uninterrupted observation. During this period there were 45 warm summers, or a proportion of 1 : 2·89. But, as in the case of mild winters, there was no periodicity of three years. Thus after the hot summer of 1763 there was not another for 12 years, and at the beginning of the present century there were 19 successive years (1799–1817) without a single hot summer. But in the case of the summers, as in that of the winters, a certain grouping is observable. In the 52 warm summers, in 31 cases 2 hot summers followed each other in succession, "so that one may wager 596 to 404 that one hot summer will be succeeded by a second." The influence of a hot summer on the succeeding autumn and winter (October to February) is that of these months 2·82 were too warm. For the individual months, with the exception of November, the probabilities are about equal. Given a summer with July, August, and September hot, and a cold January, a warm December and February may be expected. As a general rule two warm winter months may be expected after a hot summer. But warm summers differ: they do not last the same length of time, they have not the same intensity; and these variations exercise an important influence on the succeeding winter months. The author then discusses the cold winters of Berlin and the respective probabilities of the succeeding months being cold. The results of the whole investigation he sums up in three propositions arranged and stated as follows:—(1) A $\left\{\frac{\text{moderately}}{\text{very}}\right\}$ mild winter will most probably be succeeded by a $\left\{\frac{\text{cool}}{\text{hot}}\right\}$ summer. (2) A $\left\{\frac{\text{moderately}}{\text{very}}\right\}$ hot summer will most probably be succeeded by a $\left\{\frac{\text{moderately mild}}{\text{cold}}\right\}$ winter. (3) A $\left\{\frac{\text{moderately}}{\text{very}}\right\}$ cold winter will most probably be succeeded by a $\left\{\frac{\text{cool}}{\text{cold}}\right\}$ summer.

The additions to the Zoological Society's Gardens during the past week include a Suricate (*Suricata tetradactyla*) from South Africa, presented by Miss F. M. Savill; two Common Badgers (*Meles taxus*), British, presented by Lord Willoughby de Broke; a Common Marmoset (*Hapale jacchus*) from Brazil, presented by Miss Henderson; a Cereopsis Goose (*Cereopsis novæ-hollandiæ*), a Black Swan (*Cygnus atratus*) from Australia, presented by Mr. F. L. Frodsham; a Mealy Amazon (*Chrysotis farinosa*) from South America, presented by Mr. W. Hodder; two Alligators (*Alligator mississippiensis*) from the Mississippi, presented by Mr. Charles Ridley; an Alligator (*Alligator mississippiensis*) from the Mississippi, presented by Miss Heimlicher; a Red-tailed Amazon (*Chrysotis erythrura*) from Brazil, three Upland Geese (*Bernicla magellanica* ♂ ♂ ♂) from the Falkland Islands, three Wigeons (*Mareca penelope* ♂ ♂ ♂), European, purchased.

OUR ASTRONOMICAL COLUMN

Occultation of Aldebaran on May 15.—The ephemerides do not take cognisance of occultations of the brighter stars, when near to the sun's place, nor indeed, as a rule, of occultations generally which occur whilst the sun is above the horizon of the place to which the calculations are adapted. In the *Monthly Notices* of the Royal Astronomical Society for March, 1868, is a note communicated by Mr. R. S. Newall, drawing attention to an occultation of Aldebaran on May 22 in that year, when the star was little more than 8° distant from the sun, and suggesting that observation would be possible with a good equatorial, and, at any rate, would be worth trying, merely as a matter of curiosity. It does not appear from the succeeding numbers of the *Monthly Notices* that the occultation in question was anywhere observed, but on May 15 in the present year one of the same star will take place when its distance from the sun is 14½°, and some observers may be inclined to make an attempt to record the phenomenon. At the Royal Observatory, Greenwich, the star escapes occultation; in the north of England and in Scotland the times for the various observatories are as follow:—

	Disappearance G.M.T. h. m.	Angle °	Reappearance G.M.T. h. m.	Angle °
Liverpool	2 50·0	19	3 5·7	353
Stonyhurst	2 47·6	24	3 9·0	348
Glasgow	2 39·6	38	3 10·1	334
Edinburgh	2 37·9	39	3 14·2	334
Dunecht	2 35·3	45	3 16·9	328

At Dublin the star disappears at 2h. 46·2m. G.M.T., and reappears at 3h. 1·0m.; angles 19° and 354° respectively, counted as usual in the *Nautical Almanac*.

Variable Stars.—(1) Dr. Gould, in the *Uranometria Argentina*, enters into some detail with respect to the relative magnitudes of the bright stars in *Corvus*, to the discrepancies in estimating which Argelander first directed attention in vol. vii. of the "Bonn Observations." It was considered that the Cordoba observations "served to remove all doubt as to the variability, within moderate limits, of all four of these stars, thus explaining the apparently contradictory nature of previous observations." On the other hand, Mr. E. F. Sawyer, of Cambridgeport, Mass., says he carefully observed the bright stars of Corvus during the years 1882–84, and found that "β is certainly variable by nearly one magnitude, but that the other stars appear to be sensibly constant," and he thinks the whole difficulty is thus solved. From Dr. Gould's remarks, however, there is room for doubt on this point.

(2) A minimum of R Leonis may be expected about May 26. The observations from 1840 to 1883 afford indications of the existence of a perturbation in the period.

The Double-Star γ Equulei.—The duplicity of this star was detected by Mr. G. Knott in 1867; his measures in that year give for 1867·543, position 276°·84, distance 2″·131. For the epoch 1877·728 Mr. Burnham found the position 274°·5, distance 2″·16. The annual proper motion of the principal star appears to be + 0·0027s. in right ascension, and − 0″·169 in declination, and if Mr. Knott's measures of 1867 are reduced to Mr. Burnham's epoch, with these values, they become—

Position 308°·0—Distance 3″·20,

differing so widely from the Chicago results as to be strongly indicative of the binary character of the object.

ASTRONOMICAL PHENOMENA FOR THE WEEK, 1885, MAY 3–9

(For the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24, is here employed.)

At Greenwich on May 3

Sun rises, 4h. 30m.; souths, 11h. 56m. 42·0s.; sets, 19h. 24m.; decl. on meridian, 15° 48′ N.: Sidereal Time at Sunset, 10h. 11m.

Moon (at Last Quarter on May 7) rises, 22h. 32m.*; souths, 3h. 0m.; sets, 7h. 27m.; decl. on meridian, 18° 17′ S.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	4 17	11 25	18 32	12 28 N.
Venus	4 33	11 56	19 19	14 58 N.
Mars	3 59	10 51	17 43	9 27 N.
Jupiter	11 50	19 7	2 24*	13 56 N.
Saturn	6 32	14 39	22 46	22 11 N.

* Indicates that the rising is that of the preceding and the setting that of the following day.

Phenomena of Jupiter's Satellites

May	h. m.		May	h. m.	
3 ...	23 35	II. ecl. reap.	7 ...	0 4	I. ecl. reap.
5 ...	2 3	I. occ. disap.		20 12	I. tr. egr.
	23 24	I. tr. ing.	9 ...	1 38	II. tr. ing.
6 ...	1 44	I. tr. egr.		23 56	III. tr. ing.
	20 32	I. occ. disap.			

The Phenomena of Jupiter's Satellites are such as are visible at Greenwich.

Saturn, May 3.—Outer major axis of outer ring = 38″·3; outer minor axis of outer ring = 17″·4; southern surface visible.
May 4, 17h.—Venus in superior conjunction with the Sun.

GEOGRAPHICAL NOTES

THE Austrian African explorers, Prof. Frederick Paulitschke and Dr. Dominik Kammel von Hardegger, have returned from their expedition to Africa. They started from Trieste on December 30, 1884, and chiefly explored the interior of the Gallas country. The Austrian explorers have established meteorological stations at Harrar and Zeila, which will be looked after by the English Consuls Pitten and King. The collections they have brought with them, filling several cases, will constitute a very valuable addition to the Austrian Imperial Museum.

AT the January meeting of the Royal Swedish Geographical Society, Dr. F. Svenonius gave a very interesting account of his visits to certain remote parts of Swedish Lapland last summer. The speaker could not accept the theory set forth by some authorities that the word "Lapp" was derived from the Lappish *loap* or Finnish *lappi*, *i.e.* "end" or "finish," signifying the inhabitants of the end of the European continent. He believed that the word was derived from *lappa* or *lappah*, *i.e.* "cave" or "recess," a name given by the Scandinavians to this race from the habits of the Lapps in earlier times living or taking refuge in caves or recesses. It was a common thing, even now, for Lapps to take refuge in such places in bad weather, or for the night when travelling. Having referred to the remarkable structure which forms the dwelling of the Lapp, he proceeded to describe the mountains, glaciers, lakes, and waterfalls of Swedish Lapland. The mountains were more imposing seen from the Swedish than the Norwegian side, as in the latter place they were too close to the spectator. They were of two kinds, the so-called "alpine" and so-called "grass" mountains. The former were lofty and jagged, and the latter—the most common—low and rounded. The alpine mountains were composed of hornblende, gabbro, and eklogite, and the grass mountains of schist impregnated with chalk. The highest parts of Swedish Lapland were those around the sources of the river Rapaädnos, the highest top of which, Sarjektjåkko, was once believed to be the highest mountain in Sweden, and west of the Lake Pajtasjärvi, where there are two lofty peaks, Kaskasatjåkko and Kebnekaisse. The greatest glaciers in Sweden were found within these parts, the former having been named the "ice-depôt of Lapland." He estimated that about 180 square kilometres, or one-seventh of the whole area, were covered with "eternal" ice, the depth of which reached several hundred feet. It was impossible to say whether the Lapland glaciers were increasing or decreasing. Judging by other European glaciers, they should be decreasing very fast. The fact that the flora of Lapland was actually receding, which pointed in the opposite direction, and seemed to indicate a deterioration of the climate, he believed was due to the circumstance that the Lapland glaciers had an "heirloom from the Glacial Age" still to get rid of. The lakes covered a vast portion of Lapland chiefly between the mountains and the so-called "forest-land." The surface area of the lakes here was one-third of the whole of Swedish Lapland. But there were also many great lakes in the alpine districts. Of the waterfalls the most imposing were the Stora Sjöfall, 130 feet high, and Harspränget, 70 feet high, and with a volume of water estimated at 500 cubic metres per second. There were besides several beautiful but smaller falls in the Gellivara Lappmark. In conclusion, Prof. von Düben, who has travelled much in Lapland, stated that he believed that the word "Lapp" was derived from the old Finnish word *lappaa*, *i.e.* "roam about," as suggested by a great authority, viz. Prof. Friis, Professor of Lappish at the Christiania University.

GUIDO CORA's *Cosmos* for 1884 (vol. viii.) contains an attractive paper on Tahiti and the natives of Polynesia, recently visited by Dr. Filippo Rho of the Italian Royal Marine, who sailed from Callao for the Pacific waters on board the *Caracciolo* in June, 1883. The "Kanaka," or Polynesian race proper, is described as presenting many points of resemblance to the Malays, from whom the writer supposes them to have originally sprung. But the type can be best studied in Tahiti and the other eastern islands of the Pacific, where it is found in its purest state and least affected by Papuan elements. It is sub-dolichocephalic, with cephalic index 76·2; keel-shaped skull; mesorrhine nose (index 49·3); not prognathous if unmixed, although in Tahiti the facial index is 75·0, and in general conformation not far removed from the white or European type. The nose, sometimes straight, sometimes aquiline, sometimes rather short and flat, is always characterised by wide nostrils. The jaw-bones, though strong, are not prominent; face oval; eyes black, well shaped, never oblique; complexion variable from light brown or copper to olive yellow, but always fairer than that of the Malays; hair black, often coarse, generally straight, but sometimes wavy; beard scant; stature very tall and slim, although a tendency is shown here and there towards obesity. The Tahitians are of a cheerful temperament, passionately fond of song and dance, and some favourable specimens are given of their *himenè*, a term derived from the English word "hymn," a relic of the days of the Protestant missionaries before the French occupation. These *himenè* are chiefly historical, religious, warlike, or amatory, the latter often extremely pathetic, as, for instance, the elegy of the distressed maid, who flies to the woods, crowns herself like Ophelia with flowers, and dies with the name of her faithless lover on her lips. "I turn weeping from side to side of my grassy couch; alas! he is away! we are severed for ever, and I alone keep my love. I stand in the shade of the Tu tree, and wreathe myself in the flowers he loved, to bear the grief of my beloved who has forsaken me. Thou forsakest me, never to return, and I die alone like the bird that finds no branch of any tree whereon to perch." There is an amusing description of Queen Marau's visit to the Italian man-of-war, whose officers were afterwards invited to a banquet, the *menu* of which is given in Tahitian and Italian. It began with roast pork, followed by raw fish *à la taiero* (a kind of pickle made of grated coco, sliced lemons, and salt water kept in a bamboo cane), prawns, salt fish, bananas, taro, a species of mango (*Spondias dulcis*), concluding with a dessert of cocoa-nuts and oranges. A native banquet is thus a sort of *résumé* of the fauna and flora of the Society Islands.

THE *Bollettino* of the Italian Geographical Society for April publishes two interesting letters from the engineer, Count Augusto Salimbeni, who had accompanied the third Bianchi expedition to Gojam, which had such a disastrous termination. These letters, addressed to Sig. Grimaldi, Minister of Agriculture, and to Prof. Tacchini, are dated from Dildil-Jimma, Gojam, December 27, 1884, and January 2, 1885, and describe the commencement of a stone bridge over the River Temcha, the first of the kind in the country since that thrown some two centuries ago across the Abai (Upper Blue Nile) by the Portuguese. This work, so far carried out under great difficulties with the assistance of Giuseppe Andreoni from the Swiss Canton of Ticino, will consist of three arches with a total length of 50 m. and 20 m. above the stream. King Tekla-Haimanot, at whose request it was undertaken, was greatly surprised at the progress already made, and expressed his satisfaction to Count Salimbeni in these terms:—"At first I did not believe you. But it was not altogether my fault. Europeans coming here have talked to me about the splendours of their lands, have brought me handsome presents, but have never shown me any of their works in stone and mortar. Our history relates how the Portuguese, to build the bridge over the Abai, brought down fire from heaven, with which they dammed up the water. It is also said that they required a thousand oxen daily to mix the mortar. But you have asked for nothing but stones, sand, wood, and water. Your work is better than that of the Portuguese. Now I believe you." It was expected that the bridge would be finished in March.

THE same number of the *Bollettino* brings to a conclusion the important and timely paper by L. Paladini on the foundation of European colonies in Africa, and especially in Algeria and Tunis. The object of the writer is to warn Italy against rash enterprises of this sort, nearly all of which have hitherto proved to be financial and even political failures. Speaking more particularly of Algeria, he describes the results, after fifty-four years of occupation, as almost nothing compared with the vas-

expenditure of blood and treasure incurred by the French Government. The military expenditure alone, he calculates, at about a yearly average of 3,000,000*l.*, or 162,000,000*l.* to the present time. To this have to be added nearly 4,000,000*l.* for some eighty fortresses and stations of all sorts required to overawe the natives; about 1,800,000*l.* yearly for the civil administration; 8,000,000*l.* for caravanserais to develop the trade of the interior; 6,000,000*l.* for the ports of Bona, Philippeville, Algiers, Bougie, Oran, and one or two others; 8,000,000*l.* or 10,000,000*l.* for arsenals, canals, dredgings, and other hydraulic works, besides many other incidental expenses, the whole far exceeding any profits hitherto realised by the trade of the country. The writer dwells upon the rivalries and heart-burnings that have sprung up between the military and civil sections of the European community, which hate each other almost more intensely than both are detested by the natives. He shows that even agriculture has yielded no returns at all commensurate with the outlay incurred, and concludes that, if not actually insoluble, the problem how to found useful and profitable colonies in Africa will always remain one of the most difficult questions for the statesman and political economist.

THE *Boletin* of the Madrid Geographical Society for February gives a complete list of the recent acquisitions of Spain in West Africa. These comprise the west coast of the Sahara between Cape Bogador (29° 9′ N.) and Cape Blanco (20° 45′ N.), both included; in the gulf of Guinea, the coast-line stretching from the Muni River, forming the northern limit of the French possessions on the Gaboon, northwards to the Rio Campo (0° 43′ to 2° 41′ N.). On the Sahara coast six stations have already been established, and all points giving access to shipping will be permanently occupied. The old treaties with the chiefs on the Rio Benito have also been renewed, with a view to prevent the threatened advance of the French in that direction.

PROF. ESCRICHE, of Quadalajara, recently described, before a conference at Madrid, his project for "geographical parks." The geographical park is a public garden, reproducing on a certain scale, according to its extent, the geographical features of a country. It is a kind of map in relief; the principal towns would be represented by places surrounded by trees, the main ways of communication by winding paths; a succession of hillocks would act for the ranges of mountains, streams of water for the rivers. The clumps of trees within the network of roads would form varied pastures, in which the natural products of each locality would find its place among the flowers, and in the centre, where the towns should be, would be placed small structures, in which would be photographic views of the principal monuments, but especially the most important astronomical, geographical, historical, and artistic information with regard to the town represented.

BEFORE the last meeting of the Verein für Erdkunde, at Halle, Dr. Alfred Hettner described the United States of Columbia, their characteristics, and present condition, based on recent journeys there. After deducting the disputed territory on its borders, Columbia is half as large again as the German Empire. Its main geographical divisions are the isthmus region, the mountainous districts in the west belonging to the Andes system, and the low-lying plains of the Amazon and the Orinoco in the east. To the last belongs the Meta, which is very suitable for navigation, but is little used for that purpose; while the Magdalena, which is navigable for 640 kilometres to the Honda Cataract, belongs to the first division. The forest region, with palms in the lower and tree-ferns in the upper parts, extends up to 2900 m., the snow-line being 4600 m. in height. The Indian population, amongst which the Muysca (Tschibtscha) rank only behind the Incas and Astecs in civilisation, was estimated in the sixteenth century at ten millions, but are said to have been reduced by the Spaniards to one-fiftieth of that number. The whole population now is given at three millions, and, according to the estimates of the Columbians themselves, 10 per cent. of these are whites, 40 Mestizos, 35 Indians, and 15 Negroes. Trade is hampered by the bad condition of the roads. Gold, silver, coffee, and hides are the chief articles of export. Railway construction, like trade, is prevented by natural difficulties and the indolent, unpractical nature of the people.

THE *Mittheilungen* of the Vienna Geographical Society for March (Band xxviii. No. 3) contains papers on the movements of the Dachstein glacier during the period 1840-84, by Dr. Simony; an account of the latest explorations in Eastern Equatorial Africa, by Dr. Le Mounier; and the first part of a paper on the geographical work of the German Lighthouse Department in Hamburg, by Prof. Geleich. At the meeting on March 24 Dr. Lenz read a paper on the German colonies in Eastern Africa and Oceania, which is not printed in the present number.

THE Norwegian Government have decided to dispatch an expedition this summer to Finmarken, in the gunboat *Lougen*, for the purpose of effecting hydrographic researches and soundings along the coast. The cost is estimated at 1000*l.* The Swedish Government grant for this year to various scientific publications amounts to about 700*l.* A sum of 50*l.* has also been contributed towards the expenses of Mr. O. Nordstedt's algological researches in England and Scotland this summer.

FURTHER NOTES ON THE GEOLOGY OF PALESTINE, WITH A CONSIDERATION OF THE JORDAN VALLEY SCHEME[1]

THE subject was divided as follows:—(I.) The Geological Formations of Palestine and Egypt; (II.) The Wady Arabah and the Dead Sea Basin; (III.) The Jordan Valley Canal Scheme.

Since the date of the previous communication in November, 1882, much attention had been directed to the geology and physical structure of Palestine and the adjacent regions, especially Egypt. Besides the discussions in the press relative to the suggested Jordan Valley canal, an important expedition was sent out by the Palestine Exploration Fund during the winter of 1883–84, whilst about the same time Sir J. W. Dawson visited Egypt, Suez, the Lebanon, &c., and gave his results in the *Geological Magazine*. Important information relative to the Libyan Desert has lately been published by Prof. Zittel in the "Palæontographica."

I, (*a*) *Schists, Gneiss, Granite, and Porphyries.*—Dawson describes the relations of the crystalline rocks and Nubian sandstone at the First Cataract (Assouan-Syene). A lower crystalline series, which he refers to the Laurentian, penetrated by dykes of granite and diorite, is covered in almost horizontal beds by a second crystalline series consisting mainly of porphyries permeated by dykes of felsite and basalt. Incidentally it was mentioned that, according to Russegger's map, all the Nile cataracts occur where the river is passing over such crystalline areas, whilst the more tranquil stretches of water belong to the system of his Nubian sandstone. An immense mass of crystalline rocks prevails at the great bend of the Nile which has Abu Hamed for its apex: the axis of this system occurs in the Monassir country, which is the wildest region between Assouan and Khartoum. Dawson thinks that the porphyries of Mount Hor may belong to his second series of rocks, which, in more northern countries, is represented by the Arvonian and Huronian.

(*b*) "*The Nubian Sandstone.*"—This exhaustive division of the rocks between the Crystallines and the Upper Cretaceous may be resolved into three sections of different geological age. The Carboniferous age of the lower sandstone and overlying limestone of Wady Nasb has been known for certain ever since the discoveries of Mr. Holland; but Prof. Hull's party has traced this section up the Arabah, and almost as far as the Dead Sea. The middle division is Cenomanian: it is probably in the main the original Nubian sandstone of Russegger, is widely extended in Egypt, occurs in great force at Petra, and constitutes the cliffs on the east side of the Dead Sea. There remains the Lebanon division of the *soi-disant* Nubian sandstone, and this in all probability is really newer than either of the others, being well up amongst the Cretaceous limestones, and possibly on the horizon of certain lignitiferous beds occurring at Edfou on the Nile.

(*c*) *Cretaceous and Nummulitic Limestones.*—The Cretaceous beds are the most important factors in Syria, whilst in Egypt those of Eocene age are much the thickest. Sir J. W. Dawson gives a section of Jebel Attâkah (partly after Le Vaillant), where the two systems are faulted together. He considers this position on the shores of the Gulf of Suez an important one as presenting an intermediate phase in both systems, thus linking the Syrian to the African types. The Cretaceous beds in Egypt are much less calcareous than in Palestine; an abundance of rock salt, gypsum, and bitumen is noted on certain horizons (Zittel). This last circumstance is noteworthy, for it will be remembered

[1] Abstract of paper read at the meeting of the Geologists' Association, on Friday, March 6, by W. H. Hudleston, M.A., F.R.S., F.G.S., &c

that Dr. Lartet assigns to the celebrated Jebel Usdom, or Salt Mountain of the Dead Sea, a place within the Cretaceous system. But Hull's party have obtained evidence which leads them to believe that Jebel Usdom is not of Cretaceous age, but rather belongs to the marls of the Dead Sea basin. This, in fact, is almost the only point where their conclusions differ materially from those of the French geologist.

Neither in Palestine nor in Egypt is there any sharp line of demarcation between the Chalk and the Tertiary rocks, but the chalky sediments of the older Eocene follow those of the Upper Chalk with hardly any variation in their characters. And yet, according to Zittel, the palæontological boundary between the Chalk and the Eocene is clearly defined, notwithstanding the continuity of marine deposits. That author had never observed either in or above the oldest Nummulitic bed a single characteristic chalk fossil; neither did he ever find a nummulite in the chalk strata.

d. Post-nummulitic Rocks outside the area of the Dead Sea basin.—There is considerable difference of opinion as to the age of the formations that were deposited subsequent to the upheaval of the Cretaceo-nummulitic sea-bed. Those at the Isthmus of Suez are especially interesting. Dawson has named them the "Isthmian deposits," and considers them to be later than the Miocene. They occupy the highest land just north of Ismailia—thin-bedded grey limestones with vermicular holes resting on marls, sands, and clays, mostly destitute of fossils, but with some layers holding fresh-water shells, especially *Ætheria caillaudi*, which is also found in the Chalouf cutting. He concludes that a branch of the Nile discharged hereabouts, not into a marine estuary, but into a lake sometimes salt and sometimes fresh. The greater part of these "Isthmian deposits" resembled those of the terraces of the Dead Sea, presently to be considered. The period of their formation was a continental one, pliocene or post-glacial.

The subject of the recent raised beaches of the Red Sea, &c., and the probable bearing of these upon the question of the route of the Exodus was also discussed.

II. *The Wady Arabah, and the Dead Sea Basin.*—It was pointed out that Prof. Hull, in a lecture given at Dublin two years ago, maintained the River theory in opposition to the Lake basin theory, insisting that such a river flowed southerly from the Lebanon through the gorge of the Arabah into the Red Sea. During the pluvial period, according to this author, the overflow of the Jordanic lake was again through the Arabah in a southward direction. Doubts were thrown upon this hypothesis, since, if the present relative levels were maintained, an overflow would take place through the Pass of Jezreel, at a point only 285 feet above sea-level, leaving the watershed of the Arabah still 375 feet above such a Jordanic lake. These points were again brought out in considering the scheme for a Jordan Valley canal.

An account of the physical and geological structure of the Arabah was given, based chiefly upon Hull's summary, and on the work of the Royal Engineers in the late survey. The longitudinal section, by Major Kitchener and Sergeant-Major Armstrong, is a very fine piece of work, and sets at rest for ever the question of level in the long valley between the Red Sea and the Dead Sea, besides supplying an admirable *coup d'œil* of the eastern flank of one of the most extraordinary valleys in the world. The great Dead Sea fault recognised by Von Buch, Hitchcock, Lartet, and others was proved to pass down the Arabah, clinging to the roots of the eastern mountains. Prof. Hull's party observed it in several places, and two cross sections are given, showing the sedimentaries faulted against the crystalline rocks. The parallel faults near the base of Mount Hor serve to repeat the phenomena with very curious and picturesque results, as is well illustrated by Prof. Hull in his book, "Mount Seir."

The physical problems connected with these dislocations, and with the undoubted existence of the Dead Sea hollow as an independent lake-basin, dating back from a high antiquity, were partially discussed. The Dead Sea basin is separated from the southward portion of the Arabah by a watershed consisting of hard limestone covered in part by sands and gravels. This has an elevation of 660 feet, and is 45 miles from the head of the Gulf; 29 miles further north the sea-level is again reached. Hence the mass of land, through which the southern section of the Jordan Valley canal would have to be cut, is 74 miles long, with a maximum height of 660 feet, and a probable average of 250 feet.

Further proof was obtained of the independent character of the basin north of the watershed in marl deposits at an elevation of 1400 feet above the present Dead Sea level; these contain species of *Melania* and *Melanopsis* identical with some of those now existing in the fresh portions of the Jordanic basin. Hence there is little doubt that we must carry the successive lakes mentioned by Capt. Conder some stages higher than had been supposed previously. It was noted also, as bearing on this subject, that the old marls of the Jordanic lakes are not so unfossiliferous as M. Lartet would lead us to suppose. Tristram describes one species of *Melania* and two of *Melanopsis* as abundant in a semi-fossil condition in several of these old marl deposits.

Next comes the consideration of a problem which results from the adoption of the independent lake-basin theory—viz. "Since the Dead Sea has no outlet, what has become of the materials that have disappeared?" Seeing that the lateral wadies are, in the main, gorges of erosion, the difficulty is still further enhanced. That there has been some connection in past time between this curious hollow and the volcanic outbursts of the Jaulan, &c., is not improbable; indeed, it has long been suspected that an explanation of the phenomenon might, in part at least, be found in this direction. There is a partially analogous case in the meridional trough with its string of charming lakes, some fresh and some salt, which, Mr. Thompson tells us, extends along the west side of the old East African volcano, Mount Kenia: the fresh-water lake, Baringo, 3200 feet above sea-level, occupies the lowest depression of this great hollow.

III. *The suggested Jordan Valley Canal.*—The remainder of the paper was occupied in considering the northern section, by which the waters of the Mediterranean are to be admitted into the Jordanic basin, so as to convert it into an inland sea. If taken through the Vale of Esdraelon into the valley of the Jâlud (Jezreel), between Little Hermon and the Gilboa range, the length would be about 25 miles, starting from the port of Haifa under Mount Carmel. The height of land is 285 feet, and the mean depth of the cutting to the water-surface would be about 150 feet, without including the depth of the canal itself. The surface of the Vale of Esdraelon consists mainly of Post-Tertiary loams, &c., below which hard limestone, and possibly basalt, would have to be encountered. The alternative of a railway was discussed.

CHINESE INSECT-WHITE WAX

A PARLIAMENTARY paper which has recently been published (China, No. 2, 1885) contains a report of a journey through Central Sze-chu'an, which was made by Mr. Hosie, consular agent at Chung-king, chiefly for the purpose of collecting information on the subject of insect white wax, specimens of the insect wax-trees, and forms of the wax product, at the request of Sir Joseph Hooker. The report describes the country traversed, its trade and trading capabilities, and such information as was attainable on any commercial product of the district; but the portion relating to insect white wax is the most interesting part of the paper.

"Insect tree" is the name given by the Chinese in the extreme west of Sze-chu'an to what is probably the *Ligustrum lucidum* of botanists. The point will doubtless be decided at Kew by the specimens which Mr. Hosie has sent home. It is also called the winter-green or evergreen tree; while in the east of the province it is known as the "crackling flea tree," owing, it is said, to the sputtering of the wood when burned. It is an evergreen, with leaves which spring in pairs from the branches. They are thick, dark green, glossy, ovate, and pointed. In the end of May or beginning of June the tree bears clusters of small white flowers, which give place to small seeds of a dark blue colour. In the month of May, 1883, Mr. Hosie found attached to the bark of the boughs and twigs numerous brown pea-shaped excrescences or galls, in various stages of development. In the earlier stages they looked like minute univalves clinging to the bark. The larger galls were readily detachable, and, when opened, presented either a whitey-brown pulpy mass, or a crowd of minute animals, whose movements were only just perceptible to the naked eye. Last year an opportunity of examining these galls and their contents with some minuteness in the chief wax-producing locality in the province presented itself. They are very brittle, and there was found, on opening them, a swarm of brown creatures, like minute lice, each with six legs and a pair of club *antennæ*, crawling about. The great majority of the galls also contained either a small

white bag or cocoon, containing a chrysalis, whose movements were visible through the thin covering, or a small black beetle. This beetle also has six legs, and is provided with a long proboscis, armed with a pair of pincers. It is called by the Chinese the "buffalo," probably from its ungainly appearance. After a few days it turned out that each chrysalis developed into a black beetle, or "buffalo." If left undisturbed in the broken gall, the beetle will, heedless of the wax insects, which begin to crawl outside and inside the gall, continue to burrow with his proboscis and pincers in the inner lining of the gall, which is apparently his food. The Chinese believe that he eats his minute companions in the gall, or at any rate injures them with the pressure of his heavy body, and galls in which beetles are numerous sell cheaper than others. But careful investigation showed that the beetle does not eat the other insects, and that his purpose within the gall is a more useful one. When a gall is plucked from the insect tree an orifice is disclosed where it was attached to the bark. By this the wax insects escape. But if the gall remained attached to the tree no mode of escape would appear to be provided for them. The beetle provides this mode. With his pincers he gradually bores a hole in the covering of the gall, which is of sufficient size to allow him to escape from his imprisonment, and which allows egress at the same time to the wax insects. When the beetles were removed from the galls some of them made efforts to fly; but at that time their *elytræ* were not sufficiently developed, and they had to content themselves with crawling, a movement which, owing to the long proboscis, they performed very clumsily. Through the orifice thus created by the beetle the insects escape to the branches of the tree, if the gall be not plucked soon enough. When plucked, the galls are carried in headlong flight by bearers who travel through the night for coolness to the market towns, and every endeavour is made to preserve a cool temperature in order that the heat may not force the insects to escape from the galls during the journey.

The wax-tree is usually a stump, varying from three or four to a dozen feet in height, with numerous sprouts or branches rising from the gnarled top of the stem. The leaves spring in pairs from the branches. They are light green, ovate, pointed, serrated, and deciduous. The branches are rarely found more than six feet in length, as those on which the wax is produced are cut from the stems with it. The sprouts of one and two years' growth are too pliant, and it is only in the third year, when they are again sufficiently strong to resist the wind, that wax insects are placed on them. In June some of the trees bear bunches apparently of seeds in small pods, and specimens of these have been sent to Kew.

The wax insects are transferred to these trees about the beginning of May. They are made into small packets of twenty or thirty galls, which are inclosed in a leaf of the wood-oil tree, the edges of which are fastened together with rice-straw. These small packets are then suspended close to the branches under which they hang. A few rough holes are made in the leaf by means of a large needle, so that the insects may find their way through them to the branches. On emerging from the galls the insects creep rapidly up the branches to the leaves, where they remain for thirteen days, until their mouths and limbs are strong. During this period they are said to moult, casting off "a hairy garment," which has grown in this short time. They then descend to the tender branches, on the under sides of which they fix themselves to the bark by their mouths. Gradually the upper surfaces of the branches are also dotted with the insects. They are said not to move from the spots to which they attach themselves. The Chinese idea is that they live on dew, and that the wax perspires from the bodies of the insects. The specimens of the branches encrusted with wax show that the insects construct a series of galleries stretching from the bark to the outer surface of the wax. At an early stage of wax production an insect called by the Chinese the "wax-dog" is developed. Mr. Hosie was unable to obtain a specimen of this insect, but it was described to him as a caterpillar, in size and appearance like a brown bean. His theory (which, he confesses, is unsupported by outside evidence) is that the female of the "buffalo" beetle, already mentioned, deposits eggs on the boughs of the insect tree or the wax tree, as the case may be, and that the "wax-dog" is the offspring of the buffalo. There may possibly be a connection between this caterpillar and the gall containing the wax insects. It is said that during the night and early morning the insects relax their hold of the bark, and that during the heat of the day they again take firm hold of it. The owners of trees are in the habit, during the first month, of belabouring the trees with thick clubs to shake off the "wax-dog," which, they assert, destroys the wax insects. After this period the branches are coated with wax, and the "wax-dog" is consequently unable to reach his prey. The first appearance of wax in the boughs and twigs has been likened to a coating of sulphate of quinine. This gradually becomes thicker, until, after a period of from ninety to a hundred days, the wax in good years has attained a thickness of about a quarter of an inch. When the wax is ready, the branches are lopped off, and as much of the wax as possible is removed by hand. This is placed in an iron pot with water, and the wax, rising to the surface at melting-point, is skimmed off and placed in round moulds, whence it emerges as the white wax of commerce. The wax which cannot be removed by hand is placed with the twigs in a pot with water, and the same process is gone through. This latter is less white and of an inferior quality. But the Chinese, with their usual carefulness that nothing be lost or wasted, take the insects, which have meantime sunk to the bottom of the pot, and, placing them in a bag, squeeze them until they have given up the last drop of the wax. They finish their short, industrious existence by being thrown to the pigs. The market price of the wax is about *1s. 6d.* per pound. It is used chiefly in the manufacture of candles. It melts at 160° F., while tallow melts at about 95°. In Sze-chu'an it is mixed with tallow to give the latter greater consistency, and candles, when made, are dipped in melted white wax to give them a harder sheathing and to prevent the tallow from running over when they are lighted.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

CAMBRIDGE.—The following courses of lectures and practical demonstrations are being given this term:—

Physiology, Elementary, by Prof. Foster; Physiology of Circulation and Respiration, Dr. Gaskell; Central Nervous System, Mr. Langley; Chemical Physiology, Mr. Lea: Preparation Class for 2nd M.B., Mr. Hill.

Elementary Biology, Mr. Sedgwick; Anatomical Characters of the Races of Mankind, Prof. Macalister; Demonstrations on Topographical Anatomy of the Head and Neck, Prof. Macalister.

Morphology and Entomology of Vertebrata, Mr. Sedgwick; Elementary Osteology and Advanced Course on Arthropoda, Mr. Harmer; Morphology of Vertebrata, Mr. Weldon; Development of Limbs of Vertebrata, Mr. Gadow.

Elementary Botany, Prof. Babington; Morphology of Cryptogams, with practical work, Elementary and Advanced Courses, Dr. Vines; Demonstrations in Systematic Botany, Mr. Potter; Morphology of the Flower, Mr. Hicks; Physiology of Plants, with Demonstrations, Mr. F. Darwin.

Geology, Local Stratigraphy, Prof. Hughes; Waves and Tides, Mr. Hill; Principles, Dynamical and Structural, Dr. Roberts; Irregular Accumulations of Doubtful Age and Origin, Mr. Marr; Palæontology, Wm. T. Roberts: Microscopic Petrology, Mr. Harker; Field Lectures, Prof. Hughes; Palæontology of Reptiles and Birds, Mr. Gadow.

Chemistry, General Equilibrium and the Dissipation of Energy, Prof. Liveing; Organic Chemistry, Mr. Main; Elementary Course, Mr. Pattison Muir; Course for Beginners, Mr. Sell; Gas Analysis, Jacksonian Assistant; Elementary Organic Chemistry, Mr. Heycock; Demonstrations, Mr. Sell, Mr. Fenton, Mr. Neville.

Physics: Optics, Prof. Stokes; Prof. Thomson, Kinetic Theory of Gases; Elementary and Advanced Courses, Mr. Shaw and Mr. Glazebrook; Elementary Physics, Mr. Hart; Demonstrations, Mr. Shaw and Mr. Glazebrook.

Mineralogy, Prof. Lewis; Demonstration Courses, Mr. Solly.

Machine Construction, Mr. Lyon; Surveying, Demonstrators of Mechanism.

Advanced Mathematical Lectures open to the University: Waves, Mr. Glazebrook; Elastic Solids, Mr. Macaulay; Solid Geometry, Mr. Ball; Analysis, Dr. Besant; Laplace's and Bessel's Functions, Mr. Pendlebury; Calculus of Variations, Mr. H. M. Taylor; Rigid Dynamics, Mr. Webb.

SOCIETIES AND ACADEMIES

London

Royal Society, April 16.—"Note on an Experiment by Chladni." By Charles Tomlinson, F.R.S.

Lord Rayleigh, in a memoir "On the Circulation of Air in Kundt's Tubes," &c., remarks (*Phil. Trans.*, 1884, part 1, p. 1) that "it was discovered by Savart that very fine powder does not collect itself at the nodal lines, as does sand in the production of Chladni's figures, but gathers itself into a cloud, which, after hovering for a time, settles itself over the places of maximum vibration.

In Savart's memoir, "Sur les Vibrations Normales" (*An. de Ch. et de Ph.* for 1827, xxxvi. 187), the author distinctly claims the above-named discovery. At p. 190 he refers to the nodal lines of Chladni, but adds that by mixing with the sand a finer dust, such as lycopodium, "la poussière fine se réunit pour tracer d'autre lignes circulaires que ce physicien n'a pas connues," &c.

Faraday, in his critical examination of Savart's memoir (*Phil. Trans.*, 1831, p. 299) apparently takes it for granted that Savart started with an original observation.

But this interesting discovery, which has been so fruitful in beautiful results, is really due to Chladni. In his "Traité d'Acoustique," Paris, 1809, he remarks, p. 125:—"Si un peu de poussière fine est mêlée au sable, elle pourra mieux servir pour faire voir aussi les centres des vibrations, c'est-à-dire, les endroits où les parties vibrantes font les plus grandes excursions: les molécules les plus petites de la poussière s'accumuleront sur ces endroits."

Chladni is even more explicit in his "Neue Beyträge zur Akustic" (4to, Leipzig, 1817). At p. 7 he recommends "etwas *Pulvis lycopodii*" as the fine dust to be mixed with the sand; and at p. 69 he remarks that when fine dust accumulates on the centres of vibration, it is in heaps more or less round or long, &c., according to the form assumed by the vibrating part.

When Wheatstone reproduced Chladni's figures on square plates (*Phil. Trans.*, 1833, p. 593) he did not notice the remarkable figures produced by mixing a fine powder with the sand. This was the less necessary because Faraday's memoir had been so recently published, and its conclusion was so satisfactory, namely, that when a plate is vibrating, currents are established in the air lying upon the surface of the plate, which pass from the nodal lines towards the centres of maximum vibration, and then, proceeding outwards from the plate to a greater or less distance, return towards the nodal lines.

With the exception of a very few elementary specimens on a small scale, as given by Chladni and Faraday, this class of figures has been neglected by writers on physics. The author then gives directions for the production of these figures when sand and lycopodium, flowers of sulphur, &c., are used, and in a folding sheet twenty-one are represented of plates of various material and form.

April 16.—"On the General Characters of *Cymbulia*." By John D. Macdonald, R.N., M.D., F.R.S.

The Pteropoda being so purely pelagic in their habit places them out of the reach of zoologists in general; and even systematic writers, as in other cases, are often misguided by incorrect figures and descriptions made up probably from scanty or defective data, but which have, nevertheless, been handed down to us with a show of truth.

The author was impressed with the idea that the figures and descriptions of the species of *Cymbulia* extant were not reliable; and having had an opportunity of examining some specimens taken in the Indian Ocean, he found that such was really the case. In the natural position of the animal the toe of the hyaline slipper of *Cymbulia* should be taken as posterior, and the broadly-notched heel as anterior. Both animal and shell are reversed in Mr. Adams's figure of *Cymbulia proboscidea*, but this is, after all, an error of less importance than that in De Blainville's figure, in which, although the shell is represented in its proper position, the animal is reversed. A pair of eyes are also given in a position where ears alone would be possible, while there is no more evidence of the existence of eyes in *Cymbulia* than in any other genus of Pteropods. The notion of a ventral connecting lobe between the fins is a mistake, though these organs are connected above and behind so as to form a broad, continuous plate.

Zoological Society, April 21.—Prof. W. H. Flower, LL.D., V.P.R.S., President, in the chair.—Mr. Sclater exhibited and remarked on a pair of pheasants from Bala Murghab, Northern Afghanistan, belonging to H.R.H. the Prince of Wales.—Mr. G. E. Dobson, F.R.S., exhibited some skulls of *Crocidura aranea*, and pointed out that they possessed supernumerary teeth (premolars) in the upper jaw.—The Secretary exhibited, on behalf of M. George Claraz, an egg of Darwin's Rhea; and read some notes by M. Claraz on the habits and distribution of this Rhea.—Mr. G. A. Boulenger exhibited a specimen of a Brazilian Snake which had partly swallowed an Amphisbænoid Lizard. The lizard had in its turn partly eaten its way out through the body of the snake.—A communication was read from Sir Richard Owen, K.C.B., containing remarks on the structure of the heart in *Ornithorhynchus* and in *Apteryx*.—Mr. Oldfield Thomas read a paper on the characters of the different forms of the *Echidna* of Australia, Tasmania, and New Guinea, all of which he was inclined to refer to one varying species.—Dr. St. George Mivart, F.R.S., read a memoir on the anatomy, classification, and distribution of the Arctoidean Carnivorous Mammals. The author, after briefly noticing the papers of other naturalists who have of late years treated of this subject, described the main facts concerning the anatomy of the various Arctoid genera, especially as regards their osteology and dentition, and gave detailed comparisons of the proportions of the various parts of the skeleton, comparing them with those of the Æluroids and Cynoids.—Dr. F. H. H. Guillemard, F.Z.S., read the second part of his report on the collection of birds made during the voyage of the yacht *Marchesa*. The present paper gave an account of the birds collected in Borneo. It also contained notes on some birds obtained on the island of Cagayan Sulu, on the north-east coast of Borneo.

Royal Microscopical Society, April 8.—The Rev. Dr. Dallinger, F.R.S., President, in the chair.—Mr. Crisp exhibited a model of an old microscope described in an Italian work published in 1686.—Mr. H. G. Madan exhibited and described Bertrand's polarising prism. He also exhibited a modification of Ahren's double-image prism.—Mr. Dowdeswell exhibited some septic microbes from high altitudes, and detailed experiments as to bacterial germs found at various heights, notably upon the Neisen, at an elevation of about 7500 feet.—Mr. A. D. Michael gave a summary of his paper on "New British Oribatidæ." He first called attention to the nymph of *Cepheus bifiatus*, which he had just discovered; the species is very rare, and the immature stages were not known. Last September, at Keswick, Mr. Michael found two or three specimens, and instead of preserving them as examples, determined to try and breed from them. He isolated them, and after some weeks obtained a few eggs, from which he reared four larvæ; these he has carefully watched for six months until they had changed to nymphs and become full grown; he then killed and preserved two specimens of the hitherto unknown nymph, reserving the two others to rear to the imaginal condition. One was lost just before the final change, the other lived. The nymph which was exhibited was a very remarkable and beautiful creature, surrounded with concentric rows of curved serrated spines longer than the body. Mr. Michael then called attention to a new species of *Hypochthonius*, proposed to be called *H. lanatus*. The abdomen is segmented, and the segments are to a certain extent retractile, as in many insects; this enables the creature to erect or lower the long spines attached to the edges of the segments at will.—An interesting new species, to be called *Notaspis serratus*, abundantly provided with long serrated hairs, and a curious nymph of a *Damæus*, to be called *D. tenupes*, which carries its cast dorsal skins in a pyramid on its back, like a pile of dish covers, and has a central projection on each skin, forming a column to support the whole, were also shown and described, besides other new species.—Mr. Crisp called attention to some very interesting experiments by Dr. Nussbaum and Dr. Gruber, on the artificial division of infusoria. Dr. Nussbaum divided an *Oxytricha* into two halves, either longitudinally or transversely, and found the edges at the point of division were soon surrounded with new cilia. Dr. Gruber artificially divided *Stentor cæruleus* with similar results.—Mr. C. H. Kain's letter on the use of balsam of Tolu was read.—Mr. H. Mills's note on the filamentous projections on the margin of the diatom (*Stephanodiscus niagaræ*) was read, and slides in illustration were exhibited.—Mr. G. C. Karop remarked on an examination he had recently made of the saliva in a case of hydrophobia. The specimens presented the following characters:—Epithelium in large masses, most of the cells crowded with micrococci; bacilli of various lengths, and very variable in diameter. A few showed evidence

of spore formation, and were surrounded by a capsule. Micrococci abundant in masses, diplococci and short chaplets. He also exhibited a drawing of the bacilli.—Mr. J. Mayall, jun., exhibited the diamonds belonging to the ruling machine of the late F. A. Nobert, a typical one being shown under the microscope by Mr. Powell. They had been submitted to various diamond experts and workers with conflicting results, but the careful examination made by Mr. L. Fletcher of the British Museum with the goniometer, showed that in nearly every instance the edges were formed by one natural fracture and one polished face.—Mr. Hardy exhibited a colony of Vorticellæ, having the stalks agglutinated in a bundle, and covered with transparent gelatinous matter. It was found erect on leaves in colonies of 50 to 100, and appearing when loose very like large conochilus.—Mr. Cheshire exhibited a remarkable slide showing conductive nerve-threads escaped from the sheath of the ganglionic chain running through the first three segments of the abdomen of *Vespa vulgaris*.

Chemical Society April 16.—Dr. W. H. Perkin, F.R.S., Vice-President, in the chair.—The following papers were read:—A crystalline tricupric sulphate, by W. H. Shenstone.—A modified Bunsen burner, by W. H. Shenstone.—Note on the history of Thionyl Chloride, by C. Schorlemmer, F.R.S.—On the reactions of selerious acid with hydrogen sulphide and of sulphurous acid with hydrogen selenide, by E. Divers and T. Shimidzu.—On a new and simple method of quantitative separation of tellurium and selenium, by E. Divers and M. Shimosé.

Paris

Academy of Sciences, April 20.—M. Bouley, President, in the chair.—Account of a new process for liquefying oxygen, by M. L. Cailletet. This process, the result of experiments recently conducted in the Physical Laboratory of the Sorbonne, is so simple and of such easy application that it may henceforth be introduced into the ordinary practice of the laboratory, and even repeated at lectures and before public audiences.—On the various hypotheses regarding the true nature of the purple of Cassius, by M. H. Debray.—Remarks on M. Poincaré's theory respecting the influence of the lunar tides on the trade winds, by M. Faye. It is suggested that M. Poincaré should be invited to give wider scope to his studies in this branch of meteorology, with a view to more fully testing the law that he has already deduced from his remarkable observations.—Note on the differences apparently presented by the various regions of the gray cerebral substance known as psycho-motor centres, as regards their different degrees of excitability, by M. Vulpian. The author rejects Pflüger's hitherto generally accepted theory, and, from further experiments carried out on the dog, arrives at totally different results.—Nebulæ discovered and recorded at the Observatory of Marseilles, by M. E. Stephan. The nebulæ observed at this observatory during the years 1883–84 are here arranged in tables showing the order and date of their discovery, right ascension, and mean polar distance for 1885.—Experiments recently made in Holland on an application of the system of large movable tubes of the pumping apparatus constructed at the sluice-gates on the Aubors River, by M. A. de Caligny.—Explorations of the mission sent to report on the recent earthquakes in the south of Spain, by M. Fouquet. Pending the publication of a complete memoir, a summary is here given of the observations made on the scene of the disturbances, with a view to determining their extent, effects, and probable origin.—On the geological constitution of the Serrania de Ronda, which occupies the western section of the region chiefly affected by the earthquake of December 25, 1884, in Andalusia; report by MM. Michel Lévy and J. Bergeron.—On the Secondary and Tertiary formations of Andalusia (provinces of Grenada and Malaga), report by MM. M. Bertrand and W. Kilian.—On the geological constitution of the Sierra Nevada, the Alpujarras, and Sierra de Almijara, report by MM. Ch. Barrois and Alb. Offret.—On the rotation of a heavy body suspended by a point of its axis, by M. Halphen. In this paper the author completes Jacobi's theory that the rotatory movement of a heavy body around a point of its axis may be replaced by the relative movement of two bodies on which no accelerating force is exercised.—On the equilibrium of a liquid mass to which a rotatory movement has been communicated, by M. H. Poincaré.—Application of the empirical formula of mutual forces to the mechanical laws of solids and the general properties of bodies, by M. P. Berthot.—Note on two new indicators for taking the quantitative analysis alkalimetrically of the caustic bases in the presence of the carbonates, by MM. R. Engel and J. Ville.—On the volatile property of the oxygenised nitrites, by M. L. Henry.—On the formation of the alkaloids in pulmonary and other maladies, by M. Villiers.—On the part played by the winds in agriculture, their influence a chief cause of the fertility of Limagne d'Auvergne, by M. Alluard.—Note on the relation between the lunar declination and the mean latitude of the starting-points of the trade-winds, by M. A. Poincaré.—On the anatomical characters of the leaf and on epharmonism in the family of the Vismiæ, by M. J. Vesque.—On the variations in the respiration of plants at the different stages of their development, by MM. G. Bonnier and L. Mangin.—On the origin of the loam of the plateaux of Western Europe, by M. A. de Lapparent.—Note on a new method of defence against mildew in the French vineyards, by M. Minière.

Rome

Reale Accademia dei Lincei, December 14, 1884.—Influence of magnetism on embryogeny. Prof. Maggiorani made a communication to the Academy regarding his own researches on the influence of magnetism on embryogeny, and in one of the last sittings of the last academical session he made a statement as to some of the results at which he had arrived. He explained how the observations had up to that time been made on adult animals developed from magnetised eggs; in his more recent researches Prof. Maggiorani has studied the effect of magnetism on the formation of the embryo. In this case also he found that magnetism has a retarding action on the development of the embryo. In the experiments which he made in conjunction with Dr. Magini eggs that had been subjected to the action of magnets of different powers, and others that had not been so treated, were placed in an incubator. The eggs used were fresh, and every external source of disturbance was avoided. None of the eggs escaped the retarding action of the magnetism, the effect of which was found to be proportional to the strength of the magnet employed and the duration of its action. Greater activity seems to be manifested during the first ten days than during subsequent periods. In the first few days there was likewise observed the curious phenomenon of an exceptional energy in the vital functions of the embryo, an energy which contrasts with the subsequent retardation which the embryo undergoes in its own development. According to Prof. Maggiorani this last fact is a direct consequence of the initial increased energy of the vital processes, that increase of energy injuriously affecting the general nourishment of the embryo. The author concludes by proposing another explanation of the phenomenon, by means of interference, and he adduces some interesting analogies between the so-called vital force and magnetism.—On the fossil ziphioid found in the Pliocene sands of Fangonero near Siena. Signor G. Capellini read a paper on the Ziphioid (*Choneziphius planirostris*) found in the Pliocene sands of Fangonero near Siena. Two portions of the skull of this interesting delphinoid were found at Antwerp in 1809 and 1812, but hitherto no other remains of it had been discovered anywhere. Last year Prof. C. d'Ancona having acquired for the Florentine Museum portions of a skull and some other bones excavated near Siena, Prof. Capellini recognised that the fossil remains belonged to the same species of Ziphioid which had been illustrated by Cuvier in 1823 under the name of *Ziphius planirostris*. The portion of the specimen found at Siena supplies what was wanting in those obtained at Antwerp, and removes all doubt as to the true position of this singular cetacean; and enables us to establish correlations between the Upper Tertiary of Italy and Belgium, the sands of Montpellier, and the crag of England. According to Prof. Capellini, the fossil cetacean discovered near Siena is closely allied to the *Ziphius cavirostris* of the present day, a cosmopolitan species captured on several occasions even in the Mediterranean.—The English sunshine-recorder and the Italian lucimeter applied to agrarian meteorology. Prof. G. Cantoni drew the attention of the members of the Academy to the fact that at the beginning of the year Hirn had brought forward an actinometer of his own invention founded on the principle applied by the Italian Bellani to a small instrument which he reproduced, afterwards devoting himself to finding out a method for making out of it a *lucimeter* capable of being used by agriculturists. Prof. Cantoni has made numerous experiments on the lucimeter of Bellani, comparing its indications with those of the sunshine-recorder. Employing these two instruments together he

ascertained by means of the lucimeter the duration of sunshine at a given place, its intensity with relation to the height of the sun and the clearness of the air; and then by means of the sunshine-recorder the periods during which the sun shone more or less were recorded. The author advises students of vegetable physiology and agriculturists to make use of both instruments.—On the physio-pathology of the supra-renal capsules. Prof. G. Tizzioni has continued his observations on animals from which he had removed the supra-renal capsules. The result of the last experiments shows that those animals which survived the operation suffered no change in health, in nutrition, or development. In those cases in which an abnormal bronze coloration was seen in the lips and the mucous secretions of the mouth and nose, it was ascertained that this coloration stopped short at a certain point, and only in exceptional cases began to increase again so as to attain vast proportions; but there was observable a diminution, or even entire disappearance, of these pigmental spots. In none of the rabbits experimented on was there any impoverishment of the blood discoverable: the proportion of hæmoglobin appeared to be quite normal. The important fact in this communication of Prof. Tizzioni's consists in this, that the supra-renal capsule may be renewed, and that when that takes place the new capsule arises at a position situated at some distance from that occupied by the old capsule which had been removed. The tissue giving rise to the new organ is that of the sympathetic nervous system, and hence the capsules belong to the nervous system of organic life. We have thus the demonstration not only of the possibility of the reproduction of an entire organ, but also of the nature of that process; and the bases for further investigations as to the functions of the organ are now fixed.—On the Columbite of Craveggia in Valvigezzo. Signor Strüver laid before the meeting the result of his crystallographic investigations of the columbite which he found in some specimens of pegmatite forming an extensive deposit near Craveggia in Valvigezzo (province of Ossola). In these masses of pegmatite Prof. Spezzia had already discovered a new variety of beryl. The columbite investigated by Prof. Strüver is a new mineral, not only for Italy, but even for the whole chain of the Alps. The degree of hardness of its crystals was found to be 6, and under the blowpipe the presence of iron and manganese was revealed.—On sylvic acid. Dr. L. Valente has succeeded in obtaining from colophony (common rosin) a well-determined acid, called sylvic acid. This is the only well characterised acid that has been extracted from colophony since the researches instituted by Lieberman, and the reactions obtained by him by means of a supposed sylvic acid show by the approximate results that he was only operating with a mixture. Dr. Valente intends to continue his researches, the incomplete results of which he presented on this occasion on the ground of his priority. Other communications:—Drs. Ricini and Marino-Zuco reported on the reactions obtained by them by means of nitrites on ferrous salts.—Dr. Mendini reported on the results obtained in studying the action of bromine on pyrotartaric and citicemic imide.

Berlin

Physiological Society, March 13.—Dr. Goldscheider gave a short sketch of his investigations respecting points of sensation of warmth, coldness and pressure, in connection with the sense of feeling. The doctrine of the specific energies of the nerves, according to which each nerve-fibre was able to conduct only a definite quality of stimulations and sensations, had to encounter, as was known, great difficulties in connection with the sense of smell and the sense of touch, seeing that the number of smells was very manifold, and that, consequently, very many essentially different sensations were taken up and conducted by the primitive fibres of the nerves of smell, while, again, the stimuli acting on the cutaneous nerves were also qualitatively diverse. In the case of the sense of smell the difficulties would perhaps only be resolved when the very various smells were satisfactorily reduced to a few simple fundamental sensations. With respect to the sense of feeling, on the other hand, a sense which comprised the five different qualities of pain, pressure, tickling, warmth, and cold, the latest researches went to show that here in point of fact were different nerve-terminal apparatuses to be distinguished, each endowed with its own specific energy. In examining the sense of temperature in the skin by means of rounded metallic points, the speaker found that there were a very large number of points which were sensitive to cold, and also a number of other points which were sensitive to warmth. These were unequally distributed over the body, and decreased in number and density towards the periphery. They appeared to stand in a certain contrast to the fineness of the sense of touch, being found more rarely where the sense of touch was very delicate. On a more minute study of these points it was shown that they were ranged together in the form of chains, and that there were always several chains of cold or of warm points, as the case might be, radiating from one spot of the skin. These radiating centres lay, in the majority of cases, to the number of about 80 per cent., each at the root of a hair, though all hairs did not cover radiating centres of such chains, while, on the other hand, there were radiating points not situated at the roots of hairs. The chains of cold points, again, never coincided with those of warm points; but these two sets of chains lay adjacent to each other. The cold points were alone capable of generating cold impressions, while all other points of the skin never excited such cold sensations. There were, however, differences among the cold points, inasmuch as some always gave rise to the exclusive feeling of coolness, while others, even under weak stimulations, always produced only an intense feeling of cold. Entirely analogous to this arrangement was the arrangement of the warm points. Some generated the single feeling of lukewarmness, others that of warmth, and others, again, that of severe heat, no matter what the degrees of stimulation in the three different cases. Not only oscillations of temperature, but also mechanical and electrical stimulations, produced the feeling of cold at the cold points, and at the warm points the feeling of warmth. On the other hand, neither at the cold nor at the warm points did the prick of a fine needle cause a painful sensation. The cold and the warm points were anatomically sharply defined, and were constantly found respectively at the same spots of the skin. On further investigation it was, however, ascertained, after taking observations several times of small sections of the skin, that, in consequence of fatigue and habituation due to repeated stimulations, the points very soon ceased to act; but, on being left for a considerable time in repose, they came decisively into operation again at the same spots. The localisation of the sense of temperature was a highly developed one. When one measured the least distance at which two cold impressions were felt distinctly from each other, it was found at spots which contained few cold points to attain a maximum of from 4 to 6 mm., while the minimum was 0·8 mm. Dr Goldscheider had made minute topographical studies on his own body in respect of the distribution of the points of temperature, and in general he had established that the number of warm points was less than that of cold points, that there were parts of the skin where neither cold nor warm points occurred, and that other parts contained indeed a few cold but no warm points—the glabella, for example. On the other hand, there was no spot on the surface of the body where warm points were found without the presence of cold points. In the outspreading areas of the sensory nerves, especially in those of the facialis, warm and cold points were numerous; but they were sparingly found in the middle lines of the body, as also over the bones. In regard to the theory of the sensations of temperature, Dr. Goldscheider ranged himself on the side of Weber's view, and assumed that a rise of temperature in the skin generated the feeling of warmth—that is, excited the warm points, while a depression of temperature created the feeling of cold, by stimulating the cold points. The experiments on the contrasting effects of temperature were very easily explained by this theory, when it was considered that each stimulation of the cold or warm points blunted them a little, and so rendered them more insensible to the next stimulation. Dr. Goldscheider, after the greater part of his experiments were concluded, received information that, previously to him, Herr Blix had demonstrated the existence of cold and warm points, and their electrical excitability; and, so far as these two independent series of observations covered each other, they completely coincided with each other in their results. After the speaker had thus conclusively established the specific energy of the sense of feeling in respect of the sense of temperature, he applied himself to examine the sense of pressure by means of fine cork points attached to a spiral spring. He found the sense of pressure likewise distributed over the skin in the form of points; and the points of pressure, which coincided neither with the cold nor with the warm points, but occupied altogether special spots of the skin—the sites of special nerve-apparatuses—were also arranged in chain-like rows, these rows likewise radiating from particular points. On the whole, the results in respect

of the pressure points were found to correspond with those in respect of the temperature-points both as regards their distribution and the mode of their specific activity. The localisation of the sensation of pressure was still finer than that of the sense of temperature. The smallest distance at which two neighbouring points of pressure could be recognised as distinct amounted to 0·1 mm. For the sense of pressure, therefore, just as much as for the sense of cold and warmth, the existence of specific nerve terminal apparatuses provided with specific energies was demonstrated. In reference to the sensation of pain, Dr. Goldscheider was of opinion that no special nerves were to be assumed. On the other hand, he thought that between the cold, warm, and pressure-points lay the terminal apparatuses of those nerves of feeling which produced specially the sensations of touch.—Dr. Tichomirow reported first on earlier morphologic investigations he had made into the embryological development of *Bombyx mori*, and brought out specially his observations on the process of segmentation of the Bombyx ovum, on the first development of the heart, and on the occurrence of an inner skeleton in the head of this insect. He then passed to the chemical examination of the ova of the Bombyx, which he had just finished in the chemical division of the Physiological Institute. The weight of the ova was not a constant quantity, 100 ova giving weights ranging from ·02 to ·06 gr. The firm membrane of the ova had hitherto been universally regarded as consisting of chitin. The easy solution, however, of this membrane in solution of potash proved the inaccuracy of this assumption. It consisted, on the contrary, of a peculiar substance distinguishable from chitin, not only by its ready solubility in potash, but also by a perceptible ingredient of sulphur. Chemically, this substance had most relation to keratin, yet it contained less carbon than the latter, and had therefore received a special name, "chorionin." A comparison of the chemical composition of winter ova which had undergone but a partial transformation with the Bombyx ova developed into caterpillars, showed that in the latter the dry weight had suffered a little diminution, and that the high glycogenous contents of the undeveloped eggs had almost entirely disappeared in the process of development, but, on the other hand, that chitin, which was wanting in the ova, was present in perceptible quantities in the caterpillars; while the nitrogenous bases (nuclein, probably) were also present in greater quantity in the developed ova than in the undeveloped winter ova.

Meteorological Society, April 7.—Prof. Fischer spoke on metallic thermometers, and described the different kinds of thermographs which had been constructed for the measurement of temperatures by the expansion of the metals for meteorological purposes. At first only one metal was used, either in the form of a long pole fastened at one end and bearing a permanent register of temperatures attached to the other free end, or several pieces of metal were joined together in the form of a lever, to increase the thermal expansion. Later on, two or three metals in the form of plates were bound together, and the difference in the expansions of the different metals was employed as a measure of the temperature. Thermographs of this kind, composed of different metals, were still in use, especially in Switzerland. Several years ago Prof. Fischer had instituted an investigation for geodetic purposes into the rate of movement with which metals followed the atmospheric variations of temperature. The experiments were carried out with two metal points of a base instrument, and their temperatures measured with thermo-electric elements. The result of the experiment was that on a rise of atmospheric temperature the temperature of the metal was found to be constantly lower than that of the air, whereas under a fall of atmospheric temperature the temperature of the metal was warmer than that of the air. These differences were all the greater the greater was the variation of temperature, and especially when the change of temperature occurred rapidly. In consequence of these results, Dr. Maurer, of Zurich, had instituted more thorough comparisons between the readings of the metallic and quicksilver thermometers, and had arrived at results not only completely confirming those of the speaker, but further demonstrating that the differences between the registrations of the metallic and mercurial thermometers did not remain the same at all times, thus showing that the former were not to be relied on for meteorological observations.—Dr. Hellmann discussed a proposal for an inquiry into the requirements for correctly ascertaining the rainfall over a particular district or region. In order to determine how close ought to be the network of stations of observation in the lowlying plain of North Germany for the purpose of obtaining an accurate representation of the distribution of rain there, he proposed the erection of twelve rain-gauge stations over an area of about thirty-seven square kilometres, to be provided with similar rain-gauges, at which observations should continue to be taken for a number of years. One year's, and, still better, several years' observations would suffice to show what was the minimum of rain-stations necessary for the plain. The Society adopted the proposal, and empowered the Committee to carry it out.—Prof. Börnstein laid before the Society three barometric curves traced by self-registering barographs at three different points of the town on March 10. All three showed distinctly a fitful rising of the pressure—at the station situated most to the north at 3h. 28m. in the morning, at that situated south-south-east from the previous one at 3h. 40m., and at that to the south-east at 3h. 42m. From these exactly determined points of time and the distances of the three places, which were ascertained with equal precision, Prof. Börnstein calculated the velocity of propagation of the squall-like atmospheric impulse at 4 metres per second, the breadth of the wave-front at about 2900 metres, and the depth of the squall at 962 metres. From this observation it appeared how desirable it was for the study of atmospheric currents to have many barographs set up at stations situated near each other.

[In the report of the Berlin Physical Society, March 20 (NATURE, vol. xxxi. p. 596, line 29, 2nd column), for *sulphates* of iron, read *salts* of iron.]

STOCKHOLM

Academy of Sciences, April 15.—Prof. C. Malmsten communicated the results of some researches by himself on the theory of numbers.—Prof. Edlund gave a demonstration of the incorrectness of the now prevalent theory on unipolar induction.—Prof. Gyldén presented a paper by Herr K. Bohlin on the element of the orbit of the third moon of Saturn (Tethys).—The Secretary presented a paper by Prof. G. Dillner on the inversion of an algebraic integral as the expression for the radix of an algebraic equation, part 2.

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